SCIENCE ABSTRACTS.

Section A.—PHYSICS.

MAY, 1928.

GENERAL PHYSICS.

1112. Density, Compressibility and Atomic Weight of Argon.

G. P. Baxter and H. W. Starkweather. *Nat. Acad. Sci., Proc.* 14. *pp.* 57–63, *Jan.*, 1928.

Application to argon of the methods employed in examining oxygen, nitrogen, helium and neon give, for the mean density of this gas at 0° C., the values 1·78364 at 760 mm., 1·18874 at 506·667 mm. and 0·59419 at 253·333 mm. On the basis of unit value for the product PV at one atmosphere, these results give, according to Guye's method of calculation, the values 1·00030 and 1·00060 for PV at two-thirds and one-third of an atmosphere respectively. Thus, within the limits of experimental error, the value of PV changes regularly with the pressure, and the extrapolated value for zero pressure is 1·00090, which agrees satisfactorily with the numbers found by other investigators. From the limiting value of PV and the normal density of argon the limiting density may be computed to be 1·78204, and, if the corresponding values for oxygen are taken as 1·00092 and 1·42897, the calculated value of the atomic weight of argon is 39·943. The conventional calculation of the deviation from Boyle's law involves the questionable assumption that the value of PV for one atmosphere is correct. Although the uncertainty thus introduced is not great, it is considered better to find the best straight line to represent the observed values of some simple function of the density against the pressure and then to extrapolate to zero pressure. Weighting of the observed average values of PV/w at different pressures inversely as their probable errors and combination by the method of least squares gives for PV/w the expressions:—

For oxygen	$0{\cdot}699807\{1 + 0{\cdot}000927(1 - p)\}$
For nitrogen	$0{\cdot}799763\{1 + 0{\cdot}000401(1 - p)\}$
For neon	$1{\cdot}111237\{1 - 0{\cdot}000592(1 - p)\}$
For argon	$0{\cdot}560651\{1 + 0{\cdot}000901(1 - p)\}$

These equations give: (1) For the normal densities, results in excellent agreement with the observed values; (2) for the respective limiting densities, 1·42764, 1·24987, 0·90043, and 1·78204; (3) for the atomic weights, 16·000, 14·008, 20·183, and 39·944; (4) for $(PV)_0/(PV)_1$, 1·00093, 1·00040, 0·99941, and 1·00090. The value for the limiting density of oxygen yields as the limiting value of molal volume 22·4146 litres ($g = 980{\cdot}616$).

T. H. P.

1113. New Evidence of the Existence of Charges Smaller than the Electron. F. Ehrenhaft and E. Wasser. *Phil. Mag.* 5. *pp.* 225–241, *Feb.*, 1928.

This paper contains the material already published in German journals [see Abstracts 791 and 792 (1928)]. An inhomogeneous field is produced between a pointed iron rod and a hollow iron tube; the ends of these are flush with the ends of insulated encircling brass cylinders, the whole forming a composite electric condenser and magnetic pole-gap. The gradient of the field along the central axis is in the same direction as gravity, and the pole-gap can be observed with a microscope. Small test-bodies, formed by spraying a weak solution of $FeCl_3$, were employed for calibrating the magnetic field from measurements of their velocities, a knowledge of the values of H, dH/dx and HdH/dx being so obtained. The apparatus was then applied to the measurement of mass susceptibilities and of the mobilities of the particles [see Abstracts 2497 and 2659 (1926)]. The electronic charge diminishes as the density of the particle increases, so that for gold the value of $e \times 10^{10}$ is 1·04. The results are discussed. G. E. A.

1114. Mercury-Vapour Trap of Low Resistance. T. H. Johnson. *Frank. Inst., J.* 205. *pp.* 99–101, *Jan.*, 1928.

The usual type of trap, unless made from very wide tubes, seriously reduces the pumping velocity. In the present design the open end of the tube leading to the vessel to be evacuated is almost completely surrounded by the cup-shaped surface of a bulb containing liquid air. Tests have shown that the arrangement is very efficient. A. A. D.

1115. Effect of the Mass of the Pen on the Performance of Indicators. O. Holm. *Zeits. Instrumentenk.* 48. *pp.* 14–26, *Jan.*, 1928.

With engines running at rapid speeds, the natural frequency of the moving parts of the indicator must be made as high as possible. Yet the pen, which marks out the diagram, must retain its rigidity. The best shape for the pen is here evaluated as well as some of the characteristics of the most suitable spring. The paper is mathematical almost throughout. A. A. D.

1116. Some Observations on Spirit Levels. K. Lüdemann. *Zeits. Instrumentenk.* 48. *pp.* 31–39, *Jan.*, 1928.

The sensitivity of various types of level has been investigated. It is concluded that the form now in common use on surveying instruments, if used with care, is sufficiently accurate for its purpose. This type consists of a closed glass vessel with a flat top. It is displacing the older type consisting of a brass box with a glass lid. The great disadvantage of this latter is that, in the course of years, the liquid gradually evaporates, finding its way out through the cemented joint between the glass and the metal. A. A. D.

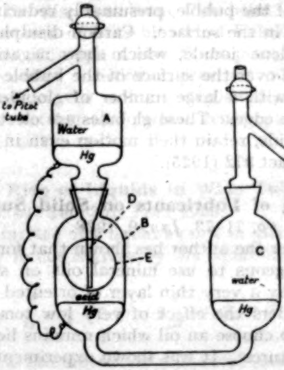
1117. Arrangement for the Viewing of Spirit Levels attached to Instruments. P. Werkmeister. *Zeits. Instrumentenk.* 48. *pp.* 39–40, *Jan.*, 1928.

An arrangement making use of prisms and a low power microscope whereby the levels may be rapidly examined before making a setting with the telescope. A. A. D.

1118. Manometer for Use with Small Pitot Tubes. G. I. Taylor. *Cambridge Phil. Soc., Proc.* 24. *pp.* 74–75, *Jan.*, 1928.

It has been shown by M. Barker (Mrs. Glauert) [see Abstract 2366 (1922)] that a Pitot tube will give correct results even when its diameter is as small as 0·04 mm., but it will be of insufficient strength and extremely slow in action. The author has, therefore, devised a manometer (made of glass) to produce a much more rapid indication.

In the sketch the mercury-acid surface in the converging capillary tube D, of diameter 0·07 to 0·2 mm., is observed through a plate-glass window E. The mercury in A is connected by a wire to that in B to obviate accidental potential differences. It is shown that the time taken for an observation is only about 1/3000 of that necessary with an ordinary manometer of the same bore. The instrument is used in conjunction with a tilting mercury-water manometer to adjust the mercury-acid surface to a standard position. T. B.



1119. Improved Mercury-Contact Manometer. *Engineer*, 145. *pp.* 181–182, *Feb.* 17, 1928.

This manometer, designed by H. Martin, is a remote reading arrangement suitable for measuring the variation of water level in tanks and boilers; in a modified form it can be used to record the flow of liquid in pipes. It consists essentially of a vertical wire-wound resistance through which a current flows. This resistance stands in a vessel containing mercury, which rises and falls, thus modifying the current. The current is read on an instrument suitably placed for observation. The mercury in part constitutes one side of an inverted U-tube manometer, the rest of the manometer consisting of oil in contact with the water in the tank. As the height of water in the tank varies so does the level of the mercury, and in consequence the current through the recording apparatus. A. A. D.

1120. Study of Films of Oil inside a Small Bubble of Gas in Water. H. A. McTaggart. *Roy. Soc. Canada, Trans.* 21. *Sect.* 3. *pp.* 249–254, *May*, 1927.

Liquids which do not mix with water fall into two groups with reference to their tendency to spread on water, the spreading coefficient, $\sigma_2 - (\sigma_1 + \sigma_{12})$, being positive or negative; σ_1 is the oil-air, σ_2 the water-air, and σ_{12} the water-oil surface tension. Oils with positive spreading coefficients, such as benzene, chloroform and oleic acid, form on the inner surface of an air-bubble in water small globules with Brownian movement, even while in the surface, the identity and movement of these globules being retained when the bubble is absorbed and the globules dispersed. Sufficiently frequent repetition of this operation results in an emulsion of oil in water, and it seems probable that this phenomenon is the principal factor in the formation of an emulsion by shaking. In water containing a trace of thorium nitrate, films of oil which spread show no small globules in Brownian movement, and no dispersion of the oil into globules occurs; moreover, the electrolyte alters the electric charge in the surface layer of the bubble, presumably reducing the concentration of free negative ions in the surface. Carbon disulphide, acetylene tetrabromide and methylene iodide, which show negative spreading coefficients, do not spread over the surface of the bubble but tend to form a pool at the bottom with a large number of globules, having Brownian movement, round the edge. These globules are electrically charged and, with the heavier liquids, retain their motion even in the thorium nitrate solution. [See Abstract 972 (1925).] T. H. P.

1121. Spreading of Lubricants on Solid Surfaces. P. Woog. *Comptes Rendus,* 186. *pp.* 71–73, *Jan.* 9, 1928.

In a previous paper the author has shown that for lubricating chronometers it is advantageous to use mineral oils on surfaces which have been " neutralised " by a very thin layer of oriented molecules of stearic acid. He now considers the effect of very low temperatures, when all that is necessary is to choose an oil which remains liquid when cold, and of very high temperatures. It was shown experimentally that at 100° C. stearic acid reacts with steel, so that the thin neutralising layer no longer has the properties of polarity and orientation which are necessary to prevent the oil from spreading. The same seems to be true of other fatty acids, which melt at a higher temperature than stearic. Other metals than steel have been experimented with and some non-metallic substances. Of these, nickel seems to be the most suitable; it gives good results even when it has been deposited by electrolysis, provided that it is dense and polished, or better burnished. H. N. A.

1122. Measurements of Viscosity and Testing of Viscometers. S. Erk. *V.D.I.* 72. *pp.* 11–14, *Jan.* 7, 1928. *From the Reichsanstalt.*

The theory of the capillary viscometer is discussed and a new form of viscometer for fundamental measurements is described. The technical instruments of Engler, Vogel-Ossag and Lawaczeck are compared and standardised in terms of absolute units. A number of oils and aniline are available as standards for the calibration of viscometers. [See Abstract 789 (1928).] F. J. B.

1123. Value of the Hagenbach Factor in Viscosity Determinations. W. Rieman. *Am. Chem. Soc., J.* 50. *pp.* 46–55, *Jan.,* 1928.

Referring to Bingham's book on *Fluidity and Plasticity,* as to the Hagenbach factor *m* to be used in the kinetic energy corrections when determining viscosity by the efflux method, the author describes his apparatus as a modification of Binghan's. Using water and methanol, he finds $m = 1 \cdot 124$, which agrees with Boussinesq (1891) 1·12; Couette assumed 1·00. The work of Bienias and Sauerwald (who found $m = 1$) is criticised. The author's value for the viscosity of methanol, 0·005508 at 25°, agrees with that of Thorpe and Rodger (similar viscosimeter) within 0·3 %. H. B.

1124. Capillarity. K. Schultze. *Kolloid Zeits.* 44. *pp.* 120–127, *Feb.*, 1928.

In order to present capillary phenomena and systems by formulæ, the author [see Abstract 2440 (1927)] proposes a series of symbols (radicals) concerning dimensions at inlet and outlet, direction of capillary, maintenance of curvature, homogeneity and wetting of the particles, branching of capillaries, etc. He discusses from this point of view the flow of liquids and the phenomena of Bütschli and of Pukall, according to whom the drying of gels and of lumps of clay takes place from inside outward, and of Bechhold, according to whom copper salts also travel outward in ceramic ware; crystals of the salt are deposited on the surface where zones differing as to wetting and surface tension are formed, while the interior is depleted of salt. H. B.

1125. Capillary Rise of Liquids in Wide Tubes. C. H. Bosanquet. *Phil. Mag.* 5. *pp.* 296–301, *Feb.*, 1928.

The form of the surface of a liquid at rest in a circular tube under the influence of capillary forces is given by the equation

$$\frac{h}{a} - \frac{a}{r}\sin\phi - a\frac{d}{dr}\sin\phi = 0.$$

Bashforth and Adams attempted the numerical solution of this equation, and later Sugden, adopting their results, gave tables of values of $\frac{r}{a}$ and $\frac{r}{b}$ for $\phi = 90°$, using in his notation $a^2 = 2a^2$. The gap between the end of his tables and the point where Rayleigh's formula for wide tubes begins to apply was interpolated graphically. The present paper gives the results of some direct computations over this region, using a method which differed from that of Bashforth and Adams in that a central difference notation was used and involved working by successive approximation. The final results extend the table given by Sugden up to a point where the capillary rise is infinitesimal. These are given in tabular form. S. G. B.

1126. Surface Tension of Solutions. W. Herz and E. Knaebel. *Zeits. phys. Chem.* 131. 5–6. *pp.* 389–404, *Feb.*, 1928.

Measurements of the surface tension of solutions of salts were made by measuring the rise in a capillary tube 0·489 mm. in diameter. The surface tensions of acid salts were compared with the surface tensions of mixtures of the neutral salt and the acid. The change of surface tension when a solution of an acid containing the same ions was added was measured. Measurements were also made of the surface tension of solutions of iodine, phenanthrene and naphthaline in various organic solvents. F. J. B.

1127. Ripple in Front of an Ascending Liquid Surface. J. Satterly and W. J. P. Mills. *Roy. Soc. Canada, Trans.* 21. *Sect.* 3. *pp.* 277–294, *May*, 1927.

When water rises within a wetted wide glass tube there is to be observed a ridge of water ahead of the surface [see Abstract 1441 (1920)]. Using a tube 3 cm. in diameter, the relation between the advance of this ripple and the velocity of rise of the water has been found. In addition, the effect of time of drainage before carrying out the measurements has been investigated. The results, both for water and solutions of KCl and NaCl, are given in a diagram. The same phenomenon was examined by means of a disc of glass partly immersed in water and rotating about an axis parallel to the surface. The ridge was studied photographically. The ripples on the two faces of the disc are not identical in shape except when the disc is at the centre of the tank. The relation between the contour of the ripples and the position of the disc in the tank has been studied in detail. It is considered, however, that more work must be done before an adequate explanation of the effect can be offered. A. A. D.

1128. Steady Motion of a Viscous Liquid due to the Translation of a Tore Parallel to its Axis. S. Ghosh. *Calcutta Math. Soc., Bull.* 18. *pp.* 185–194, *Dec.*, 1927.

Mathematical. The stream function and the pressure are determined, the squares of the velocities being neglected. W. G. B.

1129. Experimental Study of the Motion of a Viscous Liquid between Two Coaxial Cylinders. J. W. Lewis. *Roy. Soc., Proc.* 117. *pp.* 388–407, *Jan.* 2, 1928.

The results of the analysis of G. I. Taylor [see Abstract 1518 (1923)] are examined in more detail by an improved apparatus [see Abstract 252 (1925)]. Taylor's formulæ, especially that for the critical speed at which the laminar motion breaks up, are confirmed, and it is suggested that a determination of this critical speed by the apparatus could well be used for the determination of kinematic viscosities. W. G. B.

1130. Theory of Discontinuous Fluid Motion and Facts. F. Ahlborn. *Phys. Zeits.* 29. *pp.* 34–41, Jan. 1, 1928.

After noting some of the older objections to the theory of discontinuous flow, the author discusses some photographs of the initial stages of the flow past an obstacle in the form of a half-cylinder, the stream meeting the plane face. The sharp edges of the obstacle must be considered to be rounded off by small portions of the fluid, christened " gyroms," there being potential-streaming outside these. Viscosity soon causes these to become vortices, which roll along the boundary of the obstacle. When the two sets meet in the rear, stream-line flow fills practically the whole space outside the obstacle. Later these vortices combine into a vortex-pair in the wake, and this, continually fed, throws off vortices which travel down-stream. Experiments were also made with a thin-walled cylinder with a slit, placed with its axis vertical in a tank of water. When water was abstracted from within, the slit behaved as a line-sink for the outer region, in which the flow was " stream-line " throughout. When water was supplied within the cylinder, and the slit was a source, the water came out in a jet, and the way in which the " gyroms " successively thrown off form a vortex street along which the jet flows is described. W. G. B.

1131. Resistance to a Barrier in the Shape of an Arc of a Circle. L. Rosenhead, with Note by S. Brodetsky. *Roy. Soc., Proc.* 117. *pp.* 417–433, *Jan.* 2, 1928.

A solution of the problem of the circular barrier placed in any position in a streaming fluid, subject to the condition that neither of the ends of the barrier are in the "dead" fluid, *i.e.*, the radius of curvature of the stream-line is zero at each end. The results in the symmetrical case are in accord with those of Brodetsky. As a particular case of the theory the plane barrier is discussed, and the results so obtained approximate closely to those obtained from a well-known exact solution. The use of the first three constants in the Levi-Civita expansion is found to yield good approximations. Barriers convex to the stream are treated fully, whilst barriers concave to the stream yield results of interest which were confirmed by experiment, details of which are given. The effect of camber on the thrust and on the motion of the centre of pressure are of especial interest and are the subject of a special brief note appended by Brodetsky. It is shown that in an aerofoil the way in which the centre of pressure travels is dependent on the camber. Different examples are quoted and fully discussed. S. G. B.

1132. Operational Factors in Orifice Flow. H. W. Swift. *Phil. Mag.* 5. *pp.* 1–18, *Jan.*, 1928.

This paper considers certain conditions of flow which may affect the registration of an orifice to an important extent, and which are not directly attributable to hydraulic or constructional conditions, but rather to the imposed conditions of operation. It has been found experimentally that turbulence and viscosity may be operated at the same time and that their effects may be superposed under the conditions of hydraulic discharge. Cavitation is found only likely to arise to any considerable extent in practice when a meter of rather large pipe to throat ratio is installed near the open end of a pipe line, and since modern design tends to favour small values of this ratio, cavitation is becoming less and less significant. To compute the true mean rate of flow, a factor has to be introduced which depends on the form of the pulsations and upon the frequency of their recurrence. The special cases of liquid and gaseous flow and of instantaneous and intermittent pulses (constant and variable) are investigated. H. H. Ho.

1133. Stability of the Solutions of Mathieu's Equation. B. van der Pol and M. J. O. Strutt. *Phil. Mag.* 5. *pp.* 18–38, *Jan.*, 1928.

Mathieu's differential equation is of the type

$$d^2x/dt^2 + (\omega^2 + \alpha^2 \cos t)x = 0,$$

and it is the first purpose of this paper to fix the boundaries in the (α^2, ω^2)-plane between the stable modes of movement and the unstable ones. Instability itself is dealt with quantitatively. In the case of a rectangular ripple, the unstable states of motion are found to cover a larger area than the stable ones, which corresponds to the conclusion made from general considerations that there are more possibilities of unstable than of stable movement. Cases where the ripple brings about stabilisation and the reverse are considered. Generalised Mathieu functions are derived, discussed, and found to enable the solution of the Mathieu equation in any region of stable movement, although invalid in the unstable regions. The general character of the unstable regions is found to be the same in the case of a sinusoidal ripple as in that of a rectangular ripple. H. H. Ho.

1134. Formation of Vortices behind a Cylinder Moving through a Liquid. E. T. S. Walton. *Roy. Dublin Soc., Proc.* 18. *pp.* 521–534, *Jan.*, 1928.

Rods of various diameters were drawn at various speeds through water in a tank. The rods were mounted on a carriage drawn along rails above the surface; they were kept in a vertical position by a spring, and the resistance was measured by the small deflection of a mirror attached. The surface of the water was dusted with aluminium powder, and photographs of the surface behind the rod showed the vortex system. By means of two photographs at a known interval, the speed of the vortices was determined. The spacing of the vortices was found to be irregular, but the average was in fair agreement with the calculations of Kármán. The ratio of the speeds of the vortices and cylinder fell from about 0·4 (that of Kármán's theory) for small Reynolds' numbers to about 0·15 for large ones, and so the value of the circulation deduced is much less than that assumed by Kármán and Synge in their calculations of the resistance. Using the experimentally found values for the circulation, however, good agreement with the observed resistance was obtained from both Kármán's and Synge's formulæ, the latter being slightly better. W. G. B.

1135. Structure of Vortex Sheets. A. Fage and F. C. Johansen. *Phil. Mag.* 5. *pp.* 417–441, *Feb.*, 1928.

Describes an examination of the vortex sheet shed from the edge of a plate set normal to an air stream and from other bodies of various forms, such as an aerofoil, a cylinder and wedges. It is shown from estimations of vorticity and also from observations of total head that the outer boundary of a sheet can be taken as a line drawn through the points in the field of maximum velocity, V_1, and the inner boundary as the line passing through the points of minimum velocity, V_2. A close estimate of the total amount of vorticity passing a section of a sheet in unit time can be obtained from the formula $(V_1^2 - V_2^2)/2V_0^2$, where V_0 is the velocity of the undisturbed air. The motion in a sheet is steady near the body, except possibly near the inner boundary. The pressure at points in an outer boundary is slightly greater than that in the dead-air region behind the body. Air flows into a sheet through both boundaries, but at a greater rate through the outer boundary. Vorticity is shed from the two sides of an asymmetric body at the same rate. The variation of velocity across a section of a sheet depends on the form of the body, and so does the rate of increase of the breadth of the sheet with the distance down-stream. The velocity distribution in the sheet shed from a flat plate normal to the air flow agrees well with the Prandtl-Tollmien theory. At a constant forward speed, both the frequency and the longitudinal spacing of the individual vortices in the vortex street depend largely on the lateral spacing between the sheets and to a smaller extent on the form of the body. J. W. T. W.

1136. Simple Method of Measuring Low Pressures. R. J. Clark. *Journ. Sci. Instruments*, 5. *pp.* 14–15, *Jan.*, 1928.

A method of estimating very low pressures, which does not require anything but a McLeod gauge, and is sufficiently accurate for rough work, is to pump the gases from the exhausted vessel into a McLeod gauge, and measure the rate of increase of pressure therein. AUTHOR.

1137. Internal Pressure of Pure and Mixed Liquids. W. Westwater, H. W. Frantz and J. H. Hildebrand. *Phys. Rev.* 31. *pp.* 135–144, *Jan.*, 1928.

Measurement of Internal Pressures.—Defining internal pressure as $T(\partial p/\partial T)_v$, designated $T\gamma$, it can be measured on the principle of a constant volume thermometer. This was done for 8 pure liquids and 12 mixtures of 50 mole per cent. composition. Values for the former are given at 15°, 20°, 25° and 35°, and for the latter at 20°, 25° and 35°. The values of γ in atmospheres per degree at 20° are as follows: (1) heptane, 8·66; (2) acetone, 11·22; (3) carbon tetrachloride, 11·47; (4) benzene, 12·58; (5) carbon disulphide, 12·67; (6) ethylene chloride, 14·17; (7) ethylene bromide, 15·20; (8) bromoform, 15·32. The values of γ for the mixtures at 20° are, designating the components by the foregoing numbers, 1–2, 9·27; 1–3, 9·68; 1–4, 9·86; 1–5, 9·84; 1–7, 10·66; 1–8, 10·86; 3–4, 12·19; 4–5, 12·32; 4–6, 12·92; 4–8, 14·05; 2–5, 11·77; 5–7, 13·98.

Relations satisfied by $(\partial p/\partial T)_v$.—It was found, further, (1) that γ is a function of the specific or molal volume only; (2) that for each pure liquid $V^2T_1\,\gamma$ is a constant, a, V being the molal volume, and T_1 the temperature at which the pressure is 1 atmosphere (a function of molal volume); (3) that the values for the mixtures are less than additive, less than those calculated from the equation of Biron, $\gamma = \gamma_1\gamma_2/(\gamma_1N_1 + \gamma_2N_2)$, where N_1 and N_2 are the mole fractions of the components, here 0·5; (4) that they are given within 1 or 2 % by the relation $a = (a_1a_2)^{1/2}$ except in some of the mixtures of carbon disulphide, acetone and ethylene chloride—the first of these is in other respects irregular, and the last two are polar; and (5) that a still better agreement is given by considering that γV is additive.

Indirect Determination of Compressibility.—The compressibility, β, can be calculated by combining γ with the coefficient of expansion, $\alpha = \beta\gamma$. In most instances the agreement with the directly determined values is satisfactory. AUTHORS.

1138. Adhesion of Mercury to Glass. W. C. Baker. *Science*, 67. *pp.* 74–76, *Jan.* 20, 1928.

The adhesion of mercury to glass was measured by means of a plano-convex lens suspended from the arm of a balance. The lens was lowered into a quantity of mercury, kept at constant level, and the diameter of the circle of contact was measured by a microscope and micrometer scale, and from this measurement the height of the apex of the meniscus above the pool of mercury was calculated. Measurements made with different circles of contact and with different lenses all led to the magnitudes to be expected from the known constants of mercury. F. J. B.

1139. Cohesion and Related Problems. *Faraday Soc., Trans.* 24. *pp.* 53–164, *Feb., and Disc., pp.* 165–179, *March,* 1928.

A general survey of the subject comprising the following fifteen papers, together with a general discussion on these papers by various contributors:

"Cohesion: A General Survey," by **C. H. Desch.** The points discussed are: The low tensile strengths of crystals and glassy substances compared with the values calculated from physical theory; the fact that the so-called elastic limit falls with increased sensitiveness of the extensometer used; failure by fatigue under low stresses; alteration in properties of materials by cold-working; dependency of the manner of deformation on the rate and duration of application of the stress; differences in properties between the interior and boundaries of crystals; nature of crystal surfaces in relation to lubrication; the problem of adhesives and solders and that of diffusion in solids. The simplest case of cohesion is that of a single crystal having a space lattice of a high degree of symmetry, and the tensile stress required to pull the crystal apart in a direction normal to a given crystal plane would be a highly interesting physical constant.

"Mechanical and Electrical Strength and Cohesion," by **A. F. Joffé.** Born's electrical theory accounts for the density, elasticity, dielectric constant and symmetry of crystals, but as regards the absolute value of cohesion, the computed molecular forces exceed by many hundreds of times the observed strength. That this is due to the fact that the rupture of the crystal does not occur simultaneously over the whole cross-section is shown by measurements of the tensile strength of rock-salt while its surface is continually dissolving, and by subjecting a sphere of rock-salt to tension by cooling it with liquid air and then plunging it into hot water or fused lead; tensile strengths approaching the theoretical values are thus obtained. Similarly, the low dielectric strength usually observed is due to secondary effects, such as the heat evolved by the current, the production of new ions by the movement of nascent ions, irregular distribution of field, and the spreading of cracks by mechanical tensions due to the field. When these effects are avoided, the observed strength is increased 500 times, in accordance with theory. When sheets of glass or mica of continually diminishing thickness are examined, a region is finally reached where the electrical breakdown is independent of the thickness; this is considered to correspond with the true dielectric strength, which is of the order 10^8 volts per cm.

"Deformation, Rupture and Hardening of Crystals," by **M. Polányi.** Monocrystalline wires and rods, slip in single crystals, planes of slip and fracture, tenacity and the lattice theory, hardening, the bent crystal, the weakening of crystals, etc., are discussed. The geometrical mechanism of the deformation of crystals appears in agreement with earlier mineralogical investigations and to be explained in essentials, but the atomic basis of slip, fracture and twinning is still obscure. A representation of hardening founded on the condition of the bent lattice explains the main features of hardening, recovery, and recrystallisation, but not the change in the magnetic and electrical constants on deformation, the increase in the tendency for rock-salt to become coloured by sodium vapour, the influence of water on the plasticity of rock-salt, etc.

"Plasticity Problems in Metals," by **G. Sachs.** The laws of crystallography are decisive in describing the processes of deformation in single crystals, but phenomena occurring in crystalline aggregates can seldom be explained crystallographically. Thus the interpretation of various effects observed in the deformation of metals is possible only by treating the materials as homogeneous and isotropic wholes, and the necessary calculations can be carried out up to a certain limit by simple steps. Mathematical treatment is described for the development of a neck in tensile tests, the stresses arising when plastic deformation occurs under bending and torsion, the impression of a rigid punch as in a hardness test, the flow of plastic masses accompanying rolling and drawing, the internal stresses remaining after a process of deformation, etc.

"Cohesion at a Crystal Surface," by **J. E. Lennard-Jones** and **B. M. Dent.** Full understanding of surface phenomena requires a detailed knowledge of the forces outside of surfaces, and as a first step in this direction the field outside the (100) face of a crystal of the rock-salt type is considered mathematically, the face being assumed to be perfectly plain and of unlimited extent. The electrostatic field outside the crystal falls off very rapidly, whereas the van der Waals field falls off according to the inverse second or third power of the distance and so becomes relatively the more important at great distances. The need of more extensive and more detailed study of the van der Waals cohesive forces is emphasised.

"The Law of Molecular Forces," by **A. W. Porter.** No certain knowledge of molecular forces is derivable from experimental results. As regards gases, the van der Waals equation represents the behaviour of real gases with only fair approximation, the deviations amounting to 30 %; it is, therefore, not safe to make the numerical values or exact form of the "small term," a/v^2, the basis of much deduction. In the case of solids, when the molecules are considered and their effects are summed up instead of integrated, valuable results will be more likely of attainment, but difficulties due to the motions of the molecules will arise.

"Brief Review of a Study of Cohesion and Chemical Attraction," by **T. W. Richards.** The main points of a series of about forty papers, published since 1901, are summarised. Many-sided evidence indicates that every substance must exist as such by means of a balance of pressures: external pressure plus affinity pressure equals intrinsic distending pressure plus thermal pressure.

"Resistance to Shear in Metal Crystals," by **G. I. Taylor.** It appears possible to form a consistent theory of the behaviour of a single crystal strained so that it shears parallel to a crystal plane on the assumption that the resistance to shear parallel to a crystal plane of slip is not small, and that much greater concentrations of stress may occur in an unbroken crystal than in one already filled with regions of stress concentration. The alternative theory that the resistance to shear is weak in a single crystal and that it is strengthened by the formation of imperfections which prevent rows of atoms from slipping seems untenable in the case of metals like aluminium, though it may apply to metals like zinc, for which there are fewer possible crystallographically similar modes of slipping.

"Hysteresis in Relation to Cohesion and Fatigue," by **B. P. Haigh.** Experiments by means of the author's electromagnetic fatigue testing machine (*Engineer*, p. 116, July 29, 1921) show that elastic hysteresis in annealed metals is composed of three stages: the primary stage, manifested as a brief evolution of heat and seldom continuing for more than 250,000 cycles if the range of stress is maintained constant; the secondary stage, which usually extends over the greater part of the life of the test-piece, and is characterised by the relatively slow variation in the hysteresis; the tertiary stage, immediately preceding fracture, is usually only brief. Formulation of a brief description of the probable physical nature of elastic hysteresis requires a dynamic rather than a static conception of stability in metallic structure and the consideration of the thermal motions of the atoms or molecules. Elastic hysteresis must be regarded as an inherent characteristic of the state of elasticity that can be acquired by metals, and is to be ascribed to the influence of the grain boundaries and surfaces of slip within the grains rather than to the crystalline metal.

"Note on Some Fatigue Phenomena, with Special Relation to Cohesion Problems," by **H. J. Gough.** A summary is given of recent experiments made at the National Physical Laboratory on fatigue in the following aspects: cyclical stress-strain relations, nature of deformation by plastic strain (slip), hardening produced by slip, and the manner of the initiation and propagation of fatigue cracks.

"Cohesion in Surface Films," by **N. K. Adam.** As a result of work done during the past year, the structure previously proposed for monomolecular surface films [see Abstracts 1199, 1200(1926)] is abandoned, the author now inclining to the adoption of Garner's suggestion that the chains of molecules have a considerable tilt in these films (see Abstract 1189 (1927)]. Consideration of the case of urea derivatives indicates that rigidity of the films may be due to cohesion between the end groups alone, but is determined partly by the length of chains in contact; closeness of packing is determined by the length of chains, superposed on an effect due to lateral attraction between heads. Other questions discussed are: balance between the attraction of the chains to each other and to water, balance between cohesive force and thermal agitation, attraction of end groups for water, and melting points of crystals and intermolecular attractions.

"Note on Cohesion in the Crystalline State," by **F. I. G. Rawlins.** The author discusses the present state of knowledge in the domain of physics and physical chemistry concerned with the energetics of the crystalline state and, thus, ultimately with the fact of continued existence of matter in the solid form, and suggests that the nature of cohesion in special crystal lattices may be sought in a combination of the theories valid for truly heteropolar and truly homopolar types.

"Some Properties of Non-Metallic Elements in Relation to their Cohesive Forces," by **A. M. Taylor.** An explanation of cohesion in terms of the attractive forces operating between unlike charges and between electric doublets is developed. Broadly speaking, it may be stated that compressibility serves as an indication of the nature of cohesive forces, whereas hardness may be treated as a qualitative estimate of their magnitude. When high compressibilities are found in non-metallic elements or in polar compounds, it may be supposed that the units of which the crystal is composed are associated with considerable electric moment. So far only the element sulphur has been examined in the infra-red spectrum and the existence of such an electric moment in the group S_2 demonstrated.

"Cohesion at Soldered Surfaces," by **T. B. Crow.** The widely varying natures of the processes involved in the joining of substances are illustrated by reference to: (1) Glued joins of wood, in which the glue, when solidified, is actually interlocked (by a series of hooks of itself) into the wood, this being largely responsible for the enormous strength of such joins when properly made. (2) The "cohesive-adhesion" of electro-deposited nickel on steel, etc., when carried out under the conditions of the Fescol process for building up, by deposition of nickel, worn parts of machinery. From the fact that test-bars built up on these lines always fractured in the nickel itself and not at the steel-nickel surface, Heape and Grieg concluded that alloying may not be an essential of a good soldered join. These joins and also joining or sticking phenomena of many other forms represent highly complicated examples of the action of cohesion and adhesion, the study of which renders it necessary to find such a meaning for them as will render possible their quantitative application to layers or films of materials sometimes only a few molecules in thickness.

"The Colloidal State and Cohesion at the Time of Solidification," by **J. Errèra.** Evidence is cited which seems to justify the hypothesis that certain bodies pass through a colloidal state of association during solidification, a condition which would remain persistent in the solid state in the neighbourhood of the point of fusion. Further support is furnished by the results of the author's experiments, which show that lowering of the dielectric constant during solidification is quite general for media having permanent dipoles, but that, for acetic acid and various other compounds, the dielectric constant of the solid may become higher than that of the liquid. T. H. P.

1140. Deflection of Flat Plates Fixed at the Circumference. H. Carrington. *Engineering,* 125. *pp.* 31–32, *Jan.* 13, 1928.

In the theory of the deflection of elastic plates by pressure, the effect of the strain of the middle surface is often neglected. The author measured experimentally the deflection at various points under various pressures in a plate of mild annealed steel whose thickness was progressively reduced from 0·625 in. to 0·05 in. If the central deflection exceeds one-tenth of the thickness, Poisson's theory ceases to be accurate. Prescott's approximation agrees very well with the experimental results for deflections as great as measured. If the plate is deflected by air pressure, the frequencies of the lateral vibrations are increased. W. G. B.

1141. Torsion-Flexure Oscillations of Two Connected Beams. S. B. Gates. *Phil. Mag.* 5. *pp.* 97–112, *Jan.,* 1928.

This work in its original form was a contribution to the theory of wing flutter. The ordinary theory of the independent flexural and torsional oscillations of bars applies in strictness only to movement of the system *in vacuo,* since only the elastic and inertia forces are included. If the oscillation takes place in a fluid medium, the fluid reactions provide another system of forces which may or may not be negligible compared with those usually considered. If the system as a whole has a large rate of translation through the fluid, it is probable that the fluid reactions during the oscillation become important. For instance, it may be necessary to retain the aerodynamic forces when considering the vibration of an elastic component of an aeroplane in flight. A type of elastic hydrodynamic problem is thus presented which assumes some importance in aeronautics, and has not hitherto received much study. One important consequence of the retention of the fluid reaction is that the independence of the flexural and torsional oscillations is destroyed. The author investigates this condition mathematically, and works out equations which determine the first appearance of instability. E. E. F. d'A.

1142. Calculation of the Periods of Circular Membranes and Discs. R. C. J. Howland. *Phil. Mag.* 5. *pp.* 39–47, *Jan.,* 1928.

The integral equation for the deflection can be replaced (approximately) by a set of simultaneous linear equations, and from these a determinantal equation for the periods is obtained. Numerical instances show that the approximation is good for the graver nodes, but the error increases with the number of nodal diameters or circles. W. G. B.

1143. Position of the Neutral Line in Belts. R. Swyngedauw. *Comptes Rendus*, 186. *pp.* 218–220, *Jan.* 25, 1928.

Considerations are advanced to show that the neutral layer of a given belt only has a precise position for a given azimuth and that it depends on whether the pulley is the driving or driven one, on the thickness of the belt and also on the coefficient of friction. It is shown that where the belt winds on to the pulley the neutral layer of a homogeneous belt is situated at a distance from the pulley always less than the half-thickness of the belt, the distance from the pulley decreasing with increased coefficient of friction or decreased coefficient of elasticity. For all belts, where they unwind from the pulley, the neutral layer is farther from the pulley in the case of the driven than of the driving pulley, and, for homogeneous belts, in the case of the driven pulley, it is nearer the external face of the belt. [See Abstract 2798 (1927).] **Errata,** *ibid. p.* 403, *Feb.* 6, 1928. A. W.

1144. Relation between the Fourier Constants of a Periodic Function and the Coefficients determined by Harmonic Analysis. A. Eagle. *Phil. Mag.* 5. *pp.* 113–132, *Jan.*, 1928.

The paper deals with the subject for the cases of both artificial and empirical functions. It is shown that in the case of artificial functions which only possess discontinuities of a single order, the exact harmonic analysis can be found without evaluating the integrals for the Fourier constants, by using the ordinary method of harmonic analysis by selected ordinates, and multiplying the results by certain definite functions. In the case of empirical functions, the result is shown to depend upon what function is chosen to represent the case in which all the selected ordinates are zero save one. The ordinary analysis works on the $(\sin x)/x$ function; other and better functions, both artificial and analytic, are suggested, including the function given by a flexible lath made to pass through the points and hence called the lath-function. All these different functions give a remarkable measure of agreement in the factors which they indicate the coefficients of ordinary harmonic analysis should be multiplied by. AUTHOR.

1145. Hamilton-Jacobi's Differential Equation in Dynamics. J. Kunz. *Phil. Mag.* 5. *pp.* 79–82, *Jan.*, 1928.

The mechanical equations of Lagrange, of Hamilton-Jacobi, and the principle of conservation of energy have been derived from Euler's differential equation of the calculus of variation. AUTHOR.

1146. Riemannian Null Geometry. J. L. Synge and A. J. McConnell. *Phil. Mag.* 5. *pp.* 241–263, *Feb.*, 1928.

In two parts. The first, which is purely geometrical, discusses the contact of surfaces. A null-surface is defined and the characteristic lines on a null-surface are shown to be geodesic null-lines. The finite null-cone formed from all the geodesic null-lines from a point is a null-surface. Through an arbitrary subspace of $(N - 2)$ dimensions there pass two null-surfaces, formed from geodesic null-lines from the points of the subspace, two directions being defined at each point. In the second part the results are applied to optics. A generalised form of Huyghen's construction makes the history of a light wave a null-surface in space-time. The history of a light ray is a geodesic null-line. A. Wh.

1147. Angular Velocity of a Rigid Body. **E. A. Milne.** *Phil. Mag.* 5. *pp.* 289–295, *Feb.*, 1928.

A mathematical treatment of the various aspects of the problem. The proof shows that there exists a unique vector Ω which is such that the velocity of any point of the body is given by the relation $r = \Omega \Lambda r$. The motion of two given points is used to fix Ω, and it is then shown that the motion of a third point is determined in terms of Ω. The complete set of rigidity conditions are required, *viz.*, P_1 and P_2 to be rigidly connected with O and with each other, and P to be rigidly connected with O, P_1 and P_2. For the velocity r of any point the expression becomes

$$r = \Omega \Lambda r = \frac{(\dot{r}_1 \Lambda \dot{r}_2)\Lambda r}{\dot{r}_1 r_2}$$
$$= \dot{r}_1\left(\frac{r \cdot \dot{r}_2}{r_1 \dot{r}_2}\right) + r_2\left(\frac{r \cdot \dot{r}_1}{r_1 \dot{r}_2}\right).$$

The velocity of any point P of a rigid body in motion round a fixed point is a linear function of the velocities of any two given points P_1 and P_2 provided $r_1 . \dot{r}_2 \neq 0$, *i.e.*, the velocities of all points are parallel to the plane. The work is extended to the theorem of relative angular velocities. It is shown that if a rigid body or frame of reference (2) have an angular velocity Ω_2 relative to a frame of reference (1), and if (1) has an angular velocity Ω_1 relative to a frame of reference (0), then (2) has an angular velocity $\Omega = \Omega_1 + \Omega_2$ relative to (0). The angular velocity is shown to be independent of the origin of reference. The above results are used to describe the most general motion of a rigid body in terms of angular velocity. The theorem of relative angular velocities eliminates the idea of a body possessing simultaneously two or more angular velocities by treating such cases as having a definite velocity in one frame of reference, together with the angular velocity of that frame of reference in a second frame of reference, and so on. Each angular velocity can then be measured in principle by a revolution counter. S. G. B.

1148. Lowest Natural Frequency of Circular Arcs. **J. P. den Hartog.** *Phil. Mag.* 5. *pp.* 400–408, *Feb.*, 1928.

Formulæ are deduced for the first and second natural frequencies of a circular arc, hinged or clamped at its ends. It is shown that the type of vibration in which extension occurs, may, under certain conditions, have a lower natural frequency than any non-extensional type. J. S. G. T.

1149. Structure of $CoCl_2$ and $NiCl_2$. **A. Ferrari.** *Accad. Lincei, Atti*, 6. *pp.* 56–59, *July*, 1927.

Structure the same as $MgCl_2$, rhombohedric, quasi-cubic; the constants of the elementary cell in the two chlorides are very nearly the same. The sides of the 90° rhombohedron containing 16 molecules are: $MgCl_2$, 10·16 Å.; $CoCl_2$, 10·02 Å.; $NiCl_2$, 10·00 Å. A. D.

1150. Laue Photographs of Body-Centred Cubic Crystals. M. Majima and S. Togino. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 126. *pp.* 259–260, *Dec.* 20, 1927. *In English.*

A repetition with a body-centred crystal (α-iron) of previous work [see Abstract 812 (1928)]. W. H. Ge.

1151. Crystal Structure of Graphite. H. Ott. *Ann. d. Physik,* 85. 1. *pp.* 81–109, *Jan.* 18, 1928.

A detailed account is given of a determination of the structure of graphite by the layer-line method. Very pure graphite layers were obtained by dissolving away the calcium carbonate of calcspar crystals containing graphite in the form of lamellæ as an inclusion. Of about 700 crystals so obtained, six only were suitable for use. The structure found is identical with that already given by Bernal and by Hassel and Mark. The geometry of the graphite lattice is shown to indicate a trivalency of the carbon atom. The possibility of the carbon being trivalent in aromatic linkages is also considered in connection with calculations by Steiger [*Chem. Ber.* 53. *p.* 666, 1920] of the linkage energy. W. S. S.

1152. Structure of the Chondrodites. W. H. Taylor and J. West. *Roy. Soc., Proc.* 117. *pp.* 517–532, *Jan.* 2, 1928.

An X-ray study by the rotation and ionisation methods of the minerals chondrodite ($H_2Mg_5Si_2O_{10}$), humite ($H_2Mg_7Si_3O_{14}$) and clinohumite ($H_2Mg_9Si_4O_{18}$). The structures are discussed in detail. Some of the constants determined are given in the following table:—

Substance.	Number of Molecules to Cell.	*a.*	*b.*	*c.*	α.	Space Group.
Chondrodite .... (monoclinic)	2	4·733 Å.	10·27	7·87	109°·2	C_{2h}^5
Humite .... (rhombic)	4	4·738 Å.	10·23	20·86	—	V_h^{16}
Clinohumite .... (monoclinic)	2	4·745 Å.	10·27	13·68	100°·50	C_{2h}^5

W. H. Ge.

1153. Structure of Surface Films. Part X.—Phenols and Monoglycerides. N. K. Adam, W. A. Berry and H. A. Turner. *Roy. Soc., Proc.* 117. *pp.* 532–541, *Jan.* 2, 1928.

Two series with liquid expanded films of area (at no compression) different from 48 sq. Å.U. have been found, the phenols of 39 and the α-monoglycerides of 70 sq. Å.U. The hypothesis of coiled chains for the liquid expanded films cannot, therefore, be maintained. Since the heads of molecules appear to contribute to the cohesion in the expanded films, Langmuir's theory that the chains hold the films together against a disruptive force exerted by the heads appears incorrect. The monoglycerides form condensed films with close-packed heads, not appreciably rearranged by compression, area 26·3 sq. Å.U. at no compression. The condensed film of dodecyl phenol shows elastic after-working on compression and decompression. W. H. Ge.

1154. Structure of Liquids and Vitreous Solids. H. Jeffreys. *Cambridge Phil. Soc., Proc.* 24. *pp.* 19–31, *Jan.*, 1928.

The three fundamental states of matter, conceived as gaseous, crystalline and vitreous, are briefly discussed. The liquid state is conceived as a compromise between the vitreous and gaseous states. The aggregates of molecules composing it are probably similar to small pieces of a vitreous solid, and play a part similar to that of the molecules of a gas in producing viscosity. A number of free molecules migrate between aggregates.
J. S. G. T.

1155. Strength of Tellurium Crystals. E. Schmid and G. Wassermann. *ZS. f. Phys.* 46. 9–10. *pp.* 653–667, 1928.

Describes a simple method of preparing mono-crystals, which gives good results in the case of tellurium and some other metals; cylindrical rods about 10 cm. long and 2 to 3 mm. in diameter were obtained and broken under tension in a testing machine. A special device was used to hold the ends, since the material was too brittle to make clamps possible. When the angle between the most inclined prism surface of the first kind and the axis of the cylinder lay between 90° and 29° the rod broke when there was a critical normal tension of 431 g./mm.^{2} perpendicular to the above surface, which was the breaking surface. For angles between 29° and 0° this normal tension at the moment of breaking fell systematically to very small values; it appears that for these orientations the strength of the material is exceeded before the critical tension perpendicular to the prism surface is reached, and though in some cases the break appears to be along the prism surface it really starts as a small break with rough surfaces at right angles to the axis of the rod, which then continues along the prism surface, the appearance of which is thus a secondary phenomenon. In other cases for these angles the whole surface of the break is rough, and nearly perpendicular to the axis. Plastic deformation could only be observed in the case of bending; the prism faces of the first kind seem to be concerned as surfaces of translation, and the digonal axis of the first kind as direction of translation.
H. N. A.

1156. Crystal Structure of the Isomorphous Sulphates of Potassium, Ammonium, Rubidium and Cæsium. A. Ogg. *Phil. Mag.* 5. *pp.* 354–367, *Feb.*, 1928.

These sulphates form isomorphous crystals which belong to the holosymmetric class of the orthorhombic system. In this paper the elements of symmetry and the arrangement of the atoms are discussed.
J. J. S.

1157. Crystal Structure of the System Cadmium–Mercury. R. F. Mehl. *Am. Chem. Soc., J.* 50. *pp.* 381–390, *Feb.*, 1928.

Describes the method of preparation of the alloys, and the mechanical treatment required in the case of the ω-solid solution, with from 23 to 50 % of cadmium by weight, to develop a crystalline structure which gave satisfactory diffraction lines. Very fine filings were mixed with finely-ground flour and submitted to X-ray examination. The spectra for all compositions of ω-alloys are identical in type, and within the error of measurement in dimensions they agree with the space-centred tetragonal lattice of axial ratio 0·520, or the body-centred tetragonal lattice of axial ratio 0·740; these are equivalent and alternative lattices. For the first, $a_0 = 5 \cdot 570$ Å. and $c_0 = 2 \cdot 910$ Å., and there are four atoms in the unit cell. The density calculated for pure solid mercury corresponds to an atomic volume of

13·63, while that of pure cadmium is 13·01; the closeness of values accounts for the extensive solid solution formation. It seems possible that the crystal structure of pure mercury at its melting point is the same as for the ω-alloys; if this is not the case, the composition-temperature diagram of Bijl requires alteration. In α-alloys, with from 60 to 100 % of cadmium by weight, a triangular close-packed lattice of axial ratio 1·89 is found; side of unit triangle 2·980 Å. It is shown that only a small shift of the atoms is required to change from the ω-lattice to the α-lattice. The frequent assumption of intermetallic compounds in this system receives no confirmation. H. N. A.

1158. Electron Distribution in Crystal Atoms. R. J. Havighurst. *Phys. Rev.* 31. *pp.* 16–26, *Jan.*, 1928.

A critical examination of the method of obtaining the atomic structure-factor and of the Fourier analysis method of determining electron distribution in crystals. It is shown (this was previously an assumption) that the coefficients of the Fourier's series which is used in determining the electron distribution are all positive in the experimental cases dealt with (Li, C, O, F, Na, Al, Cl, Ca and Fe). Any modification in the intensity of regular reflection of X-rays, and which is caused by the Compton effect, is negligible. A note on the Schrödinger wave mechanics should be read.

W. H. Ge.

1159. Schrödinger's Function in the Problem of Two Asymmetric Centres, and the Charge of the Ions in Certain Crystal Lattices. K. F. Niessen. *Phys. Zeits.* 29. *pp.* 52–55, *Jan.* 15, 1928.

Shows that, when an electron is attracted by two centres with unequal positive charges, k_1e on the left being less than k_2e on the right, the Schrödinger function ψ of zero order differs at two points lying symmetrically on either side of the middle plane, and is greater on the left side than on the right. Since ψ^2 is proportional to the density of the electronic charge, this result can be used in studying homopolar combination, the distribution of the charge of the scattering electrons in crystal lattices, and so the intensity of the scattered X-rays. The results of the theory are exactly opposed to those of the older theory, in which the combination of two positive centres was explained by the revolution of an electron round them in an ellipse with the attracting centres at the foci. The old theory leads to large differences in the combined charges left and right in homopolar combinations, while in the new the " electron cloud " will tend to reduce the difference in charge between left and right. This agrees with the measurements of Ott on X-ray diagrams of SiC, AlN, BeO and ZnS, which show that the power of reflection of the ions in these lattices indicates the presence of approximately neutral atoms. The author assumes that the positive centres k_1e and k_2e are atoms with the structure of the Grimm-Sommerfeld theory, with shells containing four electrons and stripped of all those in the outer shell. In the diamond or wurtzite lattice $k_1 + k_2 = 8$; the total charges of the ions are $(k_1 - 4 + \delta'')e$ and $(k_2 - 4 - \delta'')e$. These are both zero according to Ott; $\delta'' = \frac{k_2 - k_1}{2}$. H. N. A.

1160. Simple Derivation of the Hydrogen Energy Levels in Wave Mechanics. A. E. Ruark. *J.O.S.A. and R.S.I.* 16. *pp.* 40–43, *Jan.*, 1928.

A derivation of the hydrogen energy levels corresponding to the circular orbits of Bohr's theory is given (1) neglecting the variability of mass and (2) taking account of this variation. The result obtained is identical with one obtained by Pauli on the old mechanics, using the relativistic variation of mass, except that in his equation E is the energy measured in the rotating system, but in the paper it is that in a resting frame, but the difference is only an apparent one. R. S. R.

1161. Measuring the Life Periods of Excited States of Atoms. Neon and Argon. K. W. Meissner and W. Graffunder. *Ann. d. Physik*, 84. 8. *pp.* 1009–1046, *Jan.* 13, 1928.

The principle of the method is the following: An emission tube E sends its radiation through an absorption tube A on to the slit of a spectrograph; the intensity of the lines on the photographic plate is photoelectrically compared to the intensity of the same lines when not passing through A; lines corresponding to a metastable state of the atom will be most strongly absorbed [see Abstract 1188 (1925)]. Tubes A and E are separately excited, and the interval τ between the excitation of A and the light flash from E is varied. This can be effected by means of: I, interrupted direct current and a rotating sector disc with contact; II*a*, a generator or oscillator of variable periodicity; or II*b*, two coupled generators of equal periods but variable phase. Method II*a*, used by Dorgelo [see Abstracts 545 and 1824 (1926)], looks simple, but the moment of interruption is not easily fixed at high potential, and the continuation of the flash from E diminishes the life period of the excitation in A, which is to be determined. Method II*b* was found preferable. For this purpose the rotors of the two generators (working through transformers, rectifiers and variable condensers) were mounted on the same shaft, but the A generator was riding on a sleeve which was given an angular displacement adjustable by a screw. According to Franck and Reiche, the excitation in A and its decay would depend upon collisions of the first order between the molecules of a pure gas, and, further, on diffusion through a foreign gas and collisions of the second order with the walls; the former would increase, the latter decrease, with increasing gas pressure, while the greater diffusion at high temperature would diminish the life. Experiments are made with neon and argon at gas pressures ranging from 0·2 to 5·6 mm., and intervals τ from 1 to 6×10^{-4} sec. The argon measurements were particularly difficult because argon is very sensitive to impurities, and the plates are little sensitive in the extreme red for the measurements up to 8500 Å.U., so that the exposures, 40 sec. for neon, had to be prolonged to 6 min. The half-periods found for the s_5 state are 7×10^{-4} sec. in neon and 3×10^{-3} sec. in argon. In the case of neon the life had a distinct maximum for pressures between 1·5 and 2 mm. Hg. Different lines of the same end term gave different absorption coefficients but similar curves.

H. B.

1162. Parachor and Chemical Constitution. A. Freiman and S. Sugden. *Chem. Soc., J. pp.* 263–269, *Feb.*, 1928.

The influence of semipolar double bonds [see Abstract 41 (1926)] studied in sulphones, chromyl chloride, bichromate potassium. Sulphonal and trional present anomalies possibly due to singlet linkages. A. D.

1163. Distribution of Energy in Molecules. L. S. Kassel. *Nat. Acad. Sci., Proc.* 14. *pp.* 23–30, *Jan.*, 1928.

In recent theories of unimolecular reactions [see Abstract 3008 (1927)] the problem arises, given a number of oscillators, classical or quantum, harmonic or otherwise, and a value for the total energy, calculate the chance that a specified one of the oscillators shall have energy in excess of some given value. Solutions of this problem for the following special cases are worked out: (1) s classical oscillators; (2) s quantum oscillators, all of one frequency; (3) s classical oscillators and r quantum oscillators, all of one frequency; (4) s classical oscillators, r quantum oscillators of frequency ν, and t of frequency μ. The application of the results to the theory of unimolecular reactions is deferred, but it is pointed out that although it would be possible, using fifteen classical internal degrees of freedom, to account for the decomposition of nitrogen pentoxide, when some or all of these degrees of freedom are quantised the observed rates can no longer be accounted for by the author's theory. W. S. S.

1164. Electrified Spherical Films and Fine Structure of Spectral Lines. L. Décombe. *Comptes Rendus,* 186. *pp.* 68–70, *Jan.* 9, 1928.

To account for the fine structure of spectral lines, Sommerfeld has advanced a remarkable explanation based on the consideration of psuedo-elliptic orbits with separate radial and azimuthal quantisations, but postulating, according to Bohr's process, a jump of electrons from one orbit to the other. It is a simple matter to liberate the theory from this strange postulate; all that is needed is to bring in as a factor the pulsations of the orbital electrons (assimilated to elastic spherical films) and to identify the luminous frequency with that of the beats intervening between the pulsations of two electrons moving in two different orbits, as has already been done in the case of circular orbits [see Abstract 541 (1928)]. In the present case, however, we must consider the vibratory frequency of the electronic film as a function not only of the kinetic energy (constantly variable when the orbit is not circular), but of the total energy which, on the contrary, remains constant for the whole duration of the motion. On this condition alone can the frequency of the beats have a fixed value. The treatment of the problem is mathematical. E. F.

1165. Life of Atomic States and the Intensity of Spectral Lines. I. S. Bowen. *Nat. Acad. Sci., Proc.* 14. *pp.* 30–32, *Jan.,* 1928.

It is pointed out that the strong lines in the spectra of nebulæ, recently explained as due to electron jumps from metastable states in oxygen and nitrogen, provide the first direct evidence that metastable states are not absolutely stable, but merely states from which the probability of a spontaneous jump in unit time is very small. Under terrestrial conditions collisions of the second kind with other atoms or with the wall of the discharge tube are so frequent that spontaneous jump with emission of the nebular line seldom occurs. In the highly rarefied nebula, however, the line appears strongly. Certain other anomalous intensities are explained in the same way by assuming suitable differences in life period. W. S. S.

1166. Structure and Dimensions of the Ethane Molecule. J. K. Morse. *Nat. Acad. Sci., Proc.* 14. *pp.* 37–40 *and pp.* 40–45, *Jan.,* 1928.

In a previous paper [see Abstract 813 (1928)] it was shown in detail that the crystal lattices of diamond and graphite could be built up of cubes having one corner shared in common between adjacent cubes.

These structures showed that simple geometrical relations connected the lattice constants and the radii of the cubes. These results were interpreted to indicate (1) that carbon atoms in combination may be conveniently treated as cubes, (2) that the radius of the carbon atom over a wide range of conditions is approximately three-quarters of an Ångström, and (3) that a union between atoms, consisting of a single electron, is a possible type of atomic union. The first of the present papers is an account of the application of these ideas to the problem of the structure of the ethane molecule. A model of this molecule, built up of cubes, is first presented by giving the coordinates of the cube centres (carbon nuclei), the cube corners (electron positions) and the possible hydrogen positions referred to three axes of reference in terms of a parameter R (radius of the carbon atom). This is followed by a description of the construction of a three-dimensional scale model of the ethane molecule, and after this there is a brief discussion of the properties of this model. The geometrical relations between the molecular structure of ethane and its space lattice; the diffraction pattern of the ethane lattice, with the calculated and observed plane spacings of ethane are dealt with in the second paper. A. E. G.

1167. Theory of the Schrödinger Equation. L. Mandelstam and M. Leontowitsch. *ZS. f. Phys.* 46. 1–2. *pp.* 131–136, 1928.

It is pointed out that the determination of the eigen energies in the Schrödinger equation $\text{div grad}\,\psi + \frac{8\pi^2 m}{h^2}[\mathrm{E} - V(x)]\psi = 0$ depends essentially on the behaviour of the potential energy function " at infinity," and the physical consequences of this fact are discussed for the particular example of a finite oscillator, $\mathrm{V}(x) = ax^2$ for $|x| < c$ and $\mathrm{V}(x) =$ const. $= \mathrm{V}_\infty$ for $|x| > c$. If $\mathrm{V}_\infty = 0$, Schrödinger's equation is soluble for any positive value of E, and it appears as though the finite oscillator is not quantised. The anomaly is explained by regarding the Schrödinger equation in this case as giving the solutions to two problems, the oscillator and the free electron, the continuous eigen value spectrum of the latter masking the line spectrum of the oscillator. W. S. S.

1168. Quantum Theory of the Electron. P. A. M. Dirac. *Roy. Soc., Proc.* 117. *pp.* 610–624, *Feb.* 1, 1928.

By employing for a point electron in an arbitrary electromagnetic field the simplest Hamiltonian which satisfies the requirements of both relativity and the general transformation theory of quantum mechanics, an explanation is obtained of all the " duplexity " phenomena without further assumption. The spinning electron model devised to account for the observed duplexity may be regarded as true as a first approximation. The present theory, in fact, indicates that the electron will behave as though possessing the magnetic moment assumed in the model, in addition to an electric moment, which is, however, imaginary and of doubtful physical significance (if any). The theory is applied to the case of motion in a central field, and the energy levels are shown to agree to a first approximation with those given by Darwin and by Pauli [see Abstract 2671 (1927)], in which the spin of the electron is allowed for. W. S. S.

1169. Undulating Theory of Two Electron Orbits. A. W. Conway. *Roy. Irish Acad., Proc.* 38. 1. *pp.* 18–28, *Jan.*, 1928.

Two-electron orbits in which the two electrons rotating about a nucleus of charge $2e$ repel each other with a force varying as the inverse cube of their distance, are dealt with by Schrödinger's method, and the results obtained compared with those given previously [see Abstract **563** (1927)] on the basis of the Bohr-Sommerfeld-Wilson quantisation principle. Certain differences in the spectral terms given by the two methods are recorded. W. S. S.

1170. Wave Mechanics of an Atom with a Non-Coulomb Central Field. Part I. Theory and Methods. Part II. Some Results and Discussion. D. R. Hartree. *Cambridge Phil. Soc., Proc.* **24.** *pp.* 89–110 *and* 111–132, *Jan.*, 1928.

Part I deals with the practical determination of the eigen values and functions of the wave equation of Schrödinger for an electron in a non-Coulomb central field for which the potential V is a function of the distance r from the nucleus. The wave function $\psi(r, \theta, \phi)$ separates into the product $S(\theta, \phi) . P(r)/r$, where $S(\theta, \phi)$ is a surface spherical harmonic and P satisfies $\frac{d^2P}{dr^2} + 2\left[E - V - \frac{l(l+1)}{r^2}\right]P = 0$. The eigen values of E corresponding to Schrödinger's boundary condition, which is here given by $P = 0$ at $r = 0$ and $r = \infty$, are now to be found by integrating the equation for P outwards from $P = 0$ at $r = 0$, and inwards from $P = 0$ at $r = \infty$ for some value of E, and then finding by trial a value of E for which the two solutions fit at intermediate values of r. A number of mathematical results are derived for simplifying the numerical work involved in this process. Part II.—In an atom consisting of closed n_k groups the force acting on a core electron due to the nucleus and remaining electrons, although not strictly centre symmetrical, is regarded as approximately so. A particular wave equation eigenfunction for the motion of a core electron in this field represents a volume distribution of charge $|\psi|^2$, with which an electric field may be associated. The fields of force obtained in this way, due to all the core electrons, should, if the system is self-consistent, reproduce the field used originally in the wave equation to derive the eigenfunctions. Using the methods of Part I, approximations to the self-consistent field are found for the atoms He, Rb^+, Na^+, and Cl^-. For He the energy parameter for the solution of the wave equation for one electron in the self-consistent field of the nucleus and the other corresponds to an ionisation potential of 24·85 volts (observed 24·6 volts), and it is expected that for other atoms the values of the energy parameter in the self-consistent field will give good approximations to the X-ray terms. This is found to be the case for Rb^+. The wave mechanical analogue of the case in which, on the orbital model, an internal and an external orbit of the same energy are possible is discussed, and it appears that on the wave mechanics the sharp separation between internal and external orbits has disappeared.

W. S. S.

1171. The Relationship between Effective Cross-Section and Quantum Jumps. E. Brüche. *ZS. f. Phys.* **47.** 1–2. *pp.* 114–130, 1928.

This paper establishes the close relationship between effective cross-section and quantum jumps, and endeavours to find a uniform treatment for the whole field. After showing the lines of agreement between the Lenard and Franck-Hertz definitions for the influences which result from impact between electron and molecule, the author discusses the cross-section conceptions in their significance for number and products of the impacts. It is shown that the separate quantum jumps must be manifested on the effective cross-section curve, probably as small jumps, and that cross-section investigations principally permit the determination of products. Further, it is established that the maxima of the effective cross-section curves may be conditioned by the influence of quantum jumps. H. H. Ho.

1172. Quantum Theory of Aperiodic Effects. J. R. Oppenheimer. *Phys. Rev.* 31. *pp.* 66–81, *Jan.*, 1928.

In Section 1 it is shown that the normalisation of the characteristic functions corresponding to a continuous spectrum, which has been introduced by Hellinger and Weyl, satisfies the requirements of the δ-normalisation of the Dirac-Jordan transformation theory. It is further shown that this normalisation makes the flux to and from infinity of systems for which an integral of motion β lies in the little range $\Delta\beta'$ equal to $(\partial E/h\partial\beta')\Delta\beta'$.

In Section 2 the condition for the validity of classical mechanics in the form grad $\lambda << 1$, where λ is the instantaneous wave-length $\lambda = (h/2\pi)[2M(E - U)]^{-1/2}$, is applied to establish Rutherford's formula for the scattering of α-particles.

In Section 3 a method is developed for computing the transition probabilities between states of the same energy, and which are represented by almost orthogonal eigenfunctions. The theory is applied to the ionisation of hydrogen atoms in a constant electric field. The period of ionisation in a field of 1 volt per cm. is $10^{10^{10}}$ sec. The bearing of such transitions on the problem of metallic conduction is discussed. AUTHOR.

1173. Production and Measurement of Molecular Beams. T. H. Johnson. *Phys. Rev.* 31. *pp.* 103–114, *Jan.*, 1928.

A new method for studying molecular beams has been developed in which the beam is detected and its intensity measured by the increase in pressure which is produced in an ionisation gauge when the gauge is moved to allow the beam to enter it through a narrow slit. This method has the advantage over other methods in use in that it is applicable to beams of molecules of non-condensable and chemically inactive gases. Many details of the construction of the new beam detector have been described and the characteristics of its operation have been studied both experimentally and theoretically. Simple kinetic theory fails to explain the observed pressure changes unless adsorption on the inner walls of the gauge is taken into account. A satisfactory hypothesis for interpreting the observations is that gas is adsorbed by the walls at a rate which is proportional to the molecular density in the volume of the gauge and liberated at a rate proportional to the number of adsorbed molecules. A value of 10^{-4} per collision is found for the probability of adsorption of a mercury molecule on glass. The sensitivity of the gauge method of detecting a beam, although seriously impaired by adsorption, still compares favourably with that of other methods in use. A study of the relation between the beam intensity and the pressure in the source chamber has been made in which the ionisation gauge method has been used for the measurements. The results show that beams of far greater intensity can be produced than were thought possible by Knauer and Stern [see Abstract 559 (1927)], who have made a similar investigation. The results of these investigators, however, are consistent with the results of the present investigation if an interpretation, different from that of Knauer and Stern, is adopted.

AUTHOR.

1174. Residual Rays from Mixed Crystals. F. Krüger, O. Reinkober and E. Koch-Holm. *Ann. d. Physik*, 85. 1. *pp.* 110–128, *Jan.* 18, 1928.

The rays from a Nernst burner, after three reflections from crystal surfaces of the type under investigation, were analysed, using an infra-red grating spectrometer. The mixed crystals studied were NaCl + KCl, KCl + RbCl, and KCl + TlCl, in each case several relative concentrations of the components being employed. The characteristic wave-lengths of the pure components were found not to occur in the residual rays from the mixed crystal; but instead a new characteristic wave-length lying between the other two was obtained. The corresponding frequency varied linearly with changes in the concentration of the components. For KCl + NaCl, which is unstable, the single characteristic wave-length appropriate to the mixed crystal, first obtained, became gradually less marked with development of the wave-lengths characteristic of the pure components.

W. S. S.

1175. Classification of the Isotopes. G. Beck. *ZS. f. Phys.* 47. 5–6. *pp.* 407–416, 1928.

Gives a table in which the different types of isotopes are classified as follows:—

Isotopic weight A	$4n$	$4n+1$	$4n+1$	$4n+3$
Number of nuclear electrons .	$2n$	$2n+1$	$2n+2$	$2n+2$
Type	β	γ	δ	α

This is the ground scheme of the table. Columns are also provided headed $a\beta$, $a\gamma$, $a\delta$, $a\alpha$ for isotopes in which a additional nuclear electrons are added. Certain regularities in the distribution of the known isotopes of the elements from fluorine onward are noted, and rules as to the "stability" of isotopes are deduced. This term refers to the probability of an isotope actually being found at an available place in the table. In the columns successive isotopes differ by the addition of an He nucleus. In the $0,\beta$ column, starting with Ne20, Ca40 is thus reached, and there are no more isotopes in this column. The addition to Ca40 of two electrons gives A40 an isobar, which starts the $2,\beta$ column; this stretches to Zn64. The addition of a He nucleus and two electrons gives Zn68, starting column $4,\beta$ and so on. It is suggested that these columns may represent shells, similar to the shells of electrons outside the nucleus, but built up mainly of He nuclei. The spin of the electrons and of the free protons, if any, may perhaps be important, and the Pauli principle may hold inside the atomic nuclei. This would prevent the formation of isotopes of very great atomic weight and small atomic number. For other suggestions of the author and predictions of new isotopes, the original paper should be consulted.

H. N. A.

1176. Search for Element 72 in Rare-Earth Minerals. W. B. Holton and B. S. Hopkins. *Am. Chem. Soc., J.* 50. *pp.* 255–258, *Feb.*, 1928.

The oxide material prepared from the most soluble fractions of two crystallisation series of the yttrium group were examined by X-rays, the arrangement of Hopkins and others [see Abstract 2256 (1926)] being used. The most intense $L\alpha_1$ line was not found, suggesting the absence of an element 72. Arc-spectrum analysis showed the presence of thorium and absence of zirconium in gadolinite, and in the most soluble fractions of the yttrium and cerium groups, as well as in the nitrates obtained from the rare earth-potassium double sulphate residues of yttrium group series accumulated during eight years. Only these last double sulphates indicated the presence of element 72 by arc-spectrum analysis. Comparison is made with the ultra-violet lines ascribed by Hansen and Werner [see Abstract 268 (1924)] to this element, hafnium or celtium. H. B.

1177. Model of the Triatomic Molecules of H_2O and CO_2. F. J. v. Wiśniewski. *ZS. f. Phys.* 47. 7–8. *pp.* 567–588, 1928.

The bricks of the models are assumed to be three univalent positive ions and three electrons, the ions lying in a straight line, one in the middle between the other two (for first approximation), and the electrons revolving in circles in a vertical plane passing through the central ion. The author deduces formulæ for the moment of inertia and the angular velocity of the electrons. Each of the two molecules H_2O and CO_2 contains only two kinds of ions. The molecule of water vapour may be symmetrical HOH, or asymmetrical HHO. The ratio of the two moments HHO/HOH would be 9/4, and that would also be the inverse ratio of the angular velocities of the electrons HOH/HHO. These velocities corresponding to two kinds of molecules should be observable in the infra-red rotation spectra, and Hettner [see Abstract 935 (1918)] had indeed observed bands of this frequency ratio in the rotation spectrum of water vapour. To determine the absolute values of the moments and the velocities the distances d between the ions must be known. These are obtained from the deduced formula $K = 1 + 5 \cdot 05 \,.\, 10^{19} d^3$ for the dielectric constant of a triatomic gas ($K_{H_2O} = 1 \cdot 000514$). The values found agree with the maxima of the wave-lengths of two pairs of absorption bands ($6 \cdot 25$ and $2 \cdot 66\,\mu$ and the halves of these wave-lengths). A formula is also deduced for the diamagnetic susceptibility of water vapour under the assumptions that the structure of the gaseous molecule is the same as that of the liquid molecule, and that the symmetric molecule has no electric moment, while the asymmetric molecule has an electric moment. The case of CO_2 is more briefly discussed; bands corresponding to the ratio of the inertia moments OCO/OOC have been observed by Schaefer and Philipps [see Abstract 2387 (1926)]. H. B.

1178. Position of the Elements of the Rare Earths in the Periodic Table. J. F. Spencer. *Am. Chem. Soc., J.* 50. *pp.* 264–268, *Feb.*, 1928.

An attempt to place the rare-earth elements in the original form of Mendeleiew's table, based on the following distinctions: (1) Elements easily separable from one another, like Na, Ag; (2) elements difficult to separate, like Fe, Co, Ni; (3) very difficult to separate, the rare earths; (4) elements practically inseparable, isotopes. Each of the elements (1) stands alone in the table; elements (2) occur in groups of three; elements (4) in groups of many elements, bismuth having five isotopes, lead at least eleven, etc. That all the elements of the rare earths are tervalent is shown by their specific heats, molecular weights of certain compounds, etc. Discussing the other properties, including sulphate solubility and the ionic magnetic moments of Weiss—who arranges these elements on two curves, from La to Sa, and Eu to Lu—the author finds places for all the elements in groups III A and B and IV A and B of series 8, 9 and 10, without destroying the symmetry of the table. H. B.

1179. Observations on the Rare Earths. Part 26. The Purification and Atomic Weight of Erbium. A. E. Boss and B. S. Hopkins. *Am. Chem. Soc., J.* **50.** *pp.* 298–300, *Feb.*, 1928.

The investigation of the atomic weight of erbium was carried out by determining the chloride to silver ratio. The material used was derived from Texas gadolinite and from bromates, and was most thoroughly purified from associated elements by fractional crystallisation. Fractionation of erbium-yttrium material from gadolinite by the nitrate fusion method yielded erbium material of constant atomic weight. The same results were obtained by the fractionation of similar material by fractional precipitation by sodium nitrite. The ratio of erbium chloride to silver was determined in six analyses, and the mean value obtained from the six determinations was **167·64**, which agrees with the accepted value of 167·7. F. J. B.

1180. Formal Extension of the Theory of Relativity and its Correlation with Electrical Theory. K. Hattori. *Tohoku Univ., Sci. Reports,* **16.** *pp.* 937–968, *Dec.*, 1927. *In English.*

A tensor satisfying the Maxwellian electromagnetic equations and identified with the electromagnetic tensor is deduced by a formal generalisation of the notion of covariant differentiation. The law of mechanical reaction due to electromagnetic forces is deduced. The field equations differ slightly from those customarily deduced, but, by suitable transformation, can be expressed in the usual form. J. S. G. T.

1181. General Theory of Relativity and the Law of Motion. A. Einstein. *Preust. Akad. Wiss. Berlin, Ber.* **32.** *pp.* 235–245, 1927.

In continuation of previous work [see Abstract 2228 (1927)], the author shows that the hypothetical law of motion assumed in the previous paper arises as a consequence of the field equations, provided one considers a point singularity having central symmetry and being static in character. J. S. G. T.

1182. Fundamental Equation of Wave Mechanics and Metrics of Space. H. T. Flint and J. W. Fisher. *Roy. Soc., Proc.* **117.** *pp.* 625–629, *Feb.* 1, 1928.

The classical and quantum theories of electromagnetism are correlated by a law of metrics of space-time, the wave equation appearing as a law of metrics in four-dimensional space just in the same way as the law of gravitation is a law of geometry. [See also Abstract 2670 (1927).] J. S. G. T.

1183. Relativity and Quantum Theory. H. T. Flint. *Roy. Soc., Proc.* **117.** *pp.* 630–637, *Feb.* 1, 1928.

Quantum theory and the metrics of space are correlated in a theory which assumes that $(ds)^2$ is equal to $\lambda^2 g_{mn} dx^m dx^n$, where λ is a function of position and the g's are ordinary gravitational components, and the square of a displacement, A^m, is similarly given by $\lambda^2 g_{mn} A^m A^n$. The further assumption is made that $\delta\lambda/\lambda = L_s\delta r^s$, and L_s is interpreted by quantum phenomena as described by Schrödinger's equation, which is deduced. The path of an electron is shown to comprise integral multiples of a fundamental unit of length h/m; time also is measured in terms of a fundamentally indivisible unit. A periodicity of frequency m/h is, therefore, associated with the electron. The natural scale factor, λ, is associated with atomic phenomena. J. S. G. T.

1184. Minimum Proper Time and its Applications (1) to the Number of the Chemical Elements (2) to Some Uncertainty Relations. H. T. Flint and O. W. Richardson. *Roy. Soc., Proc.* 117. *pp.* 637–649, *Feb.* 1, 1928.

It is shown that in a four-dimensional universe the smallest observable length is h/mc, whilst the smallest observable proper time is h/mc^2, where h and c have their usual significance and m is the rest-mass of a particle considered. These relations involve a limit of the atomic numbers N of the chemical elements. Actually the greatest value of N is 92 for uranium. Consideration of circular electronic orbital motion with quantum number unity indicates that $N < hc/2\delta 2\pi e^2$, which gives $N < 98$, on substitution of the usual values of h, c and e. A consideration of the radiation emitted in the combination of an electron with a massive nucleus gives the same result. The limit $N \ngtr hc/2\pi e^2$ is required by relativistic formulæ for the motion of an electron round a nucleus. Extension of the theory to circular orbits of quantum number n shows that $n(n/\overline{n + 1})^{1/2} \nless 2\pi e^2 N/ch$. The limitation $N < 98$ applies only to atoms having K electrons therefore. In the case of the nucleus, N and n are shown to be connected by the relation $N \nless 6{\cdot}82 \times 10^{-3} n^{3/2}/(n + 1)^{1/4}$. In the case of uranium this gives an upper limit $n \ngtr$ about 2000. The theory developed is applied to the discussion of the uncertainty relations in the theory of optical instruments, more especially the theory of resolving power, developed by Bohr and Heisenberg. J. S. G. T.

1185. Definition of the Notion of Time. G. v. Gleich. *ZS. f. Phys.* 47. 3–4. *pp.* 280–298, 1928.

Modern speculations concerning the nature of time and space are discussed, and it is pointed out that the space-time world of the relativity theory is merely an artificial image. The two different ideas of time of the relativity theory are solely consequences of physically unfounded transformations of the coordinates of the image, or of unjustified applications of the theory of invariants. T. H. P.

1186. Principle of Relativity and Law of Gravitation. Girault. *Comptes Rendus*, 186. *pp.* 580–582, *Feb.* 27, 1928.

General expressions for the motion of a massive particle in a gravitational field having spherical symmetry are deduced, and it is shown that the Einstein-Schwarzschild equations are particular cases of this equation. Four functions occurring in the analysis are shown to be derivable from the single expression $e^{-2m/r}$, where the symbols have the customary significance. J. S. G. T.

1187. Law that Light-Rays are the Null-Geodesics of a Gravitational Field. E. T. Whittaker. *Cambridge Phil. Soc., Proc.* 24. *pp.* 32–34, *Jan.*, 1928.

It is shown, applying only the theory of the characteristics of partial differential equations and without introducing the idea of frequency at all, that in a gravitational field, any electromagnetic disturbance which is propagated without spreading into three dimensions must necessarily have the form of a null-geodesic of space-time. J. S. G. T.

1188. Results of Classical Wave Mechanics Obtained by Using the Methods of Relativity Mechanics. T. Lewis. *Phil. Mag.* 5. *pp.* 408–416, *Feb.*, 1928.

The spatial path of a particle moving in a conservative field according to the laws of classical electrodynamics is shown to be the projection of a null-geodesic in space-time, and this geodesic is the " track " of a ray of its associated wave. The equations of motion of the particle and of a ray of its associated wave follow from the same principle of variation. The same set of equations, expressed in canonic form, represents the motion of the particle and the ray it follows. The phase, regarded as a function of time and position, is shown to be a solution of the Hamilton-Jacobi equation, and Schrödinger's equation is derived from the principle of variation [see Abstract 2541 (1926)]. J. S. G. T.

1189. Non-Existence of Ether Drift. A. Piccard and E. Stahel. *Comptes Rendus*, 186. *pp.* 430–431, *Feb.* 13, 1928.

The authors reply to Brylinski's criticism of their work and results [see Abstract 558 (1928)]. J. S. G. T.

1190. Velocity of the Earth. E. Brylinski. *Comptes Rendus*, 186. *pp.* 579–580, *Feb.* 27, 1928.

The author explains his disagreement with the conclusions drawn by Piccard and Stahel from the results of their interference experiments carried out in order to detect evidence of an ether drift. [See also Abstracts 558, 559 (1928) and preceding Abstract.] J. S. G. T.

METEOROLOGY AND GEOPHYSICS.

1191. Results Obtained by Testing Solarimeters with Pyrheliometer Tubes. L. Gorczyński. *Monthly Weather Rev.* 55. *pp.* 488–490, *Nov.*, 1927.

An extensive series of tests carried out at Ariana, Tunis, and Montpellier, S. France, with pyrheliometric tubes and solarimeters showed that a constant reduction factor could be obtained. For the latter the cover glass should be of 50 mm. diameter and 1 mm. thick to give satisfactory results, since with thicker glasses of smaller diameter the reduction factor depends upon the altitude of the sun. An improved form of thermopile was used, while with the pyrheliometer a four-fold magnification obtained with a sphero-cylindrical lens may be useful for low intensities, particularly when light filters are used. [See also Abstract 615 (1927).] R. S. R.

1192. Ozone Layer of the Upper Atmosphere at Night. D. Chalonge. *Comptes Rendus*, 186. *pp.* 446–448, *Feb.* 13, 1928.

The view having been advanced that the constancy of the ozone layer was due to the opposing action of two groups of solar ultra-violet radiations, one creative and the other destructive of O_3, tests of this layer were made at night, when there is no solar activity. A quartz spectrograph on an equatorial mounting was used, and photographs of the radiations received from the moon, at various altitudes in the five to six days around full moon, were obtained. These indicate that the ozone layer (1) remains of constant thickness during any individual night, and (2) is thicker at night than by day. Further observations are required to confirm the results. [See also Abstract 2003 (1927).] R. S. R.

1193. Periodicities in the Nile Floods. C. E. P. Brooks. *Roy. Meteorolog. Soc., Mem.* 11. *pp.* 9–26, *Jan.*, 1928.

1194. Tides in Oceans on a Rotating Globe. Part I. G. R. Goldsbrough. *Roy. Soc., Proc.* 117. *pp.* 692–718, *Feb.* 1, 1928.

In the present paper an examination is first made of the tides in an ocean comparable with the Southern Ocean in order to find how far such an ocean is capable of producing tides in an adjacent ocean. Next, taking an ocean whose depth varies as the square of the cosine of the latitude and which is bounded from pole to pole by two meridians of longitude, a solution is given for the semi-diurnal tide. The form of solution does not permit of the determination of the free periods of oscillation of such an ocean, but does give the critical depths at which resonance takes place. By taking the bounding meridians at 60° apart, results roughly applicable to the Atlantic Ocean are obtained and strong evidence adduced that the Atlantic semi-diurnal tides are due to partial resonance. H. H. Ho.

1195. Earth's Thermal History. J. Joly. *Phil. Mag.* 4. *pp.* 338–348, *Aug.*, 1927.

Jeffreys' contention that a body losing heat and supplied also by an internal source will approach a condition of equilibrium, not permitting of a permanent oscillation of temperature, is examined. In the case of the earth, the coming into existence of a molten substratum would materially reduce the tides. This effect produces a reaction upon the whole outer crust tending to dissipate heat by convection and reintroducing the whole cycle. W. A. R.

1196. J. Joly and the Earth's Thermal History. H. Jeffreys. *Phil. Mag.* 5. *pp.* 208–214, Jan., 1928.

The author discusses various criticisms he advanced in the *Geological Magazine*, Nov., 1926, of Joly's theory of the earth's thermal history and Joly's reply to these criticisms. In particular he objects to the idea of periodicity in the flux of heat. The conditions of convection in a layer of fluid of great horizontal extent are applied to the basaltic layer and the temperature gradient maintained there. R. S. R.

1197. Earth's Thermal History. J. Joly. *Phil. Mag.* 5. *pp.* 215–221, *Jan.*, 1928.

The author repeats his objections to H. Jeffreys' views, using the analogies of the geyser, the air tester and the sublimation engine. He examines afresh Jeffreys' arguments regarding temperature gradient and convection [see preceding Abstract] and controverts the view of a downward rise of temperature adequate to counteract the effects of pressure in raising the melting point. Reasons are also given for adopting approximately 37 km. as the continental thickness. R. S. R.

ASTROPHYSICS.

1198. Astronomical Time and the Rotation of the Earth. W. de Sitter. *Nature,* 121. *pp.* 99–106, *Jan.* 21, 1928. *Supplement.*

The nature of the secular acceleration and fluctuations are explained by reference to three astronomical clocks, the rotation of the earth, the period of revolution of the moon, and the apparent motion of the sun and other planets. It is shown that there must be two independent effects at work, sudden changes in the value of the tidal retardation and sudden changes in the moment of inertia of the earth. The origin of these changes is obscure. A. Wh.

1199. Distribution of Brightness on the Solar Disc. H. Kienle and A. Juška. *ZS. f. Phys.* 47. 5–6. *pp.* 426–429, 1928.

Measurements made with a comparatively simple apparatus constructed as follows: By means of a cœlostat having the principal mirror parallel to the earth's axis and the auxiliary mirror adjustable in azimuth and altitude, each 10 cm. in diameter, and a concave mirror of 6 metres focus, a solar image 55·2 mm. in diameter was thrown on to a screen containing a diaphragm 0·2 mm. in diameter. The disc also carried a coordinate reticulum with the diaphragm as its starting point, so that the position of the solar image could be at any moment determined visually. Behind the diaphragm was the window of a potassium-argon cell. The current was measured by a unifilar electrometer, the thread being earthed over a constant fluid resistance. The readings were registered photographically with five-fold enlargement of the abscissæ and an amplitude of 40 to 60 mm. for the full intensity of the sun's centre. The experiments were made in undecomposed light, corresponding to an effective wave-length of about 485 *mμ*. The chief results were: (1) The diminution in brightness was accurately measured to within 1 % of the rim; (2) the values obtained agree with Moll's, *i.e.*, the contrast between rim and centre is smaller than that given by Abbot; (3) the intensity of the disperse radiation immediately adjoining the rim averages 3 % of the central intensity; (4) the measurements point to an abrupt diminution towards the rim. These results are confirmed by observations made during the solar eclipse of 1927 in Lapland. E. F.

1200. Structure of the Fraunhofer Lines and the Quantitative Spectral Analysis of the Solar Chromosphere. A. Unsöld. *ZS. f. Phys.* 46. 11–12. *pp.* 765–781, 1928.

In a previous paper the author has shown that the breadth of the Fraunhofer lines depends on the damping of the radiation in the thick chromosphere. The theory is here further developed in connection with a paper by Milne, and new measurements of the variation of intensity in various solar lines are recorded which enable a test of the theory to be made. It becomes possible to calculate the number of atoms, N . H, in a vertical column 1 sq. cm. in section, reaching from the surface of the photosphere to the outer boundary of the chromosphere, which are concerned in the production of a given line. The following values were found for $N . H \times 10^{-18}$: Na 0·026, Al 0·070, Ca^{+} 23·3, Sr^{+} 0·021, Ba^{+} 0·004, Ca 0·034, Sr 0·00011. The partial pressure of the free electrons in the chromosphere was calculated as about 10^{-6} atmos. Considering the thermal ionisation deduced from Saha's formula, it is possible to calculate the total number of ions of each of the elements Na, Al, Ca, Sr and Ba, and the values obtained are in good agreement with those of Payne, who assumed that the average chemical constitution of all stars is the same. Finally, it is shown that for the higher members of the Balmer series the form of the intensity curves from the centre to the edges of the lines differs greatly from that deduced from the theory, since these lines are very sensitive to disturbance, and pressure effects are of importance. H. N. A.

1201. Emission Spectrum of the Solar Edge. A. Unsöld. *ZS. f. Phys.* 46. 11–12. *pp.* 782–788, 1928.

The theory developed by the author in papers on the structure of the Fraunhofer lines [see preceding Abstract] is used to deduce the appearance to be expected in the Hα line when it is observed at the edge of the sun, with the slit perpendicular to the edge. As previously described, the emission line joins up directly with the absorption line below, and becomes narrower above, but this is due to the use of unsuitable apparatus, and does not agree with the theory. The theoretical curves of equal brightness are plotted, and show that the middle of the line in the chromosphere remains dark like the absorption line below, while on either side of this a bright emission is to be expected. This is well seen in a reproduction of a photograph taken at the Einsteinstiftung at Berlin. The shape of the outwardly projecting bright wings on either side of the central dark line corresponds to that deduced from the theory. H. N. A.

1202. Motion of a Perihelion of Planets. P. Fatou. *Comptes Rendus,* 186. *pp.* 65–68, *Jan.* 9, 1928.

A mathematical dissertation establishing an elementary and direct method of demonstrating the shifting, and calculating the mean motion of, the perihelion of a minor planet. E. F.

1203. Ellipsoidal Stratification in a Rotating Fluid Mass. P. Dive. *Comptes Rendus,* 186. *pp.* 294–296, *Jan.* 30, 1928.

It is shown that whatever the law of flattening and of the density of homogenous layers, there is a system of rotations defined by the equation

$$\omega^2 = \frac{2}{\rho}\left\{\int_0^{\rho_1} \frac{\partial U}{\partial r^2} d\rho - \rho_1 \left[\frac{\partial U}{\partial r^2}\right]_{\rho=\rho_1}\right\}$$

which will maintain the initial stratification. A. Wh.

1204. Retrograde Satellites. E. Belot. *Comptes Rendus,* 186. *pp.* 296–298, *Jan.* 30, 1928.

The theory of the inversion of the velocities of the outermost satellites of a system is discussed, and it is considered that while the retrograde satellites in a direct system are the more stable, the direct satellites in a retrograde system are somewhat less stable and may not be formed. A. Wh.

1205. Stellar Radiation and Thermodynamic Fluctuations. T. Bialobjeski. *Accad. Polonaise Sci. et Lettres, Bull. No. 6a. pp.* 349–362, *June,* 1927.

Part of the total radiation of a star is supposed to be due to local fluctuations from the ideal thermodynamic equilibrium, and an attempt is made to estimate the magnitude of the effect. It is concluded that the whole of the stellar radiation can be accounted for on these lines. A. Wh.

1206. Problem of Three Bodies. Case where One of the Bodies Collides Successively with the Other Two. Kiveliovitch. *Comptes Rendus,* 186. *pp.* 361–362, *Feb.* 6, 1928.

In the problem of three bodies (p_0pp') it is shown that of an infinitude of orbits involving a collision p_0p, an orbit can be found that necessitates also the collision $p'p$ after a time u. Subsequently the collision p_0p occurs again, and hence the orbit is periodic. It is defined by four independent conditions and the motion is plane. The system is of the second order. A. Wh.

1207. Distances, Dimensions and Total Magnitudes of Twenty-nine Anagalactic Objects. K. Lundmark. *Ark. f. Mat. Astron. och Fysik, Stockholm,* 20*b. No.* 3. [6 *pp.*], 1927.

Assuming that the dispersion in the absolute magnitudes of the separate stars in anagalactic objects is small, it is possible to compute the distances for a number of them without making any assumption as to their size or total brightness. Observations of Novæ, Cepheids and O stars give $-6\cdot7$ as the mean absolute magnitude of the brightest stars in five anagalactic objects, and this is near the value -7 which is the upper limit for the stars in the Milky Way. A table is included for thirty objects of their total magnitude (m), magnitude of brightest stars (M_b), total absolute magnitude (M_t), apparent diameter (d), type on Wolf's scheme, relative distance, parallax, and absolute dimensions in light years (D); the parallaxes and relative distances being derived from the assumption that $\overline{M}$ for the brightest stars is $-7\cdot0 \pm 0\cdot5$, which ought to be certain within 40%. There is a close connection between M_b and m; the dispersion in M_t is of the same order of magnitude as found from double stars and clusters so that the total m's can be used to obtain a fair approximation of the distances of anagalactic objects. The relations between log D and M, and between log d and m are practically linear. M. 31 and M. 81 are exceptionally large. The "late" spirals (w-type) are smaller than the "earlier" compressed s and r types, possibly because the outer faint extensions are not photographically recorded. The mean value of the absolute dimensions of all the objects is 10,860 ± 1820 light-years. [See Abstract 1685 (1927).] A. S. D. M.

1208. Statistics concerning Binary Stars. K. Lundmark. *Ark. f. Mat. Astron. och Fysik, Stockholm,* 20*a. No.* 12. [5 *pp.*], 1927.

A discussion of the statistical characteristics of a card catalogue of orbital elements of over 400 spectroscopic and visual binaries, giving as results: Millar Barr's suggested peculiar distribution of periastra (in 1908) is not confirmed, and there seems no relation between periastra and eccentricities; the correlation factor (r) between the log of the period and the eccentricity is $r = 0\cdot686 \pm 0\cdot036$ (from 399 systems), the periods varying from 0·1 day to 1000 years; a third of the stars have small eccentricities lying between $e = 0\cdot00$ and $e = 0\cdot10$; 30 % of the stars lie between classes B_0 and A_0; the mass of a binary gets smaller as the eccentricity of the system grows larger (from 347 systems). A. S. D. M.

1209. Some Statistical Results from Counts of Double Stars in the Greenwich Astrographic Catalogue. H. Groot. *Roy. Astron. Soc., M.N.* 88. *pp.* 51–55, *Nov.,* 1927.

The author searched the catalogue, which contains 178,784 stars, for double stars of a separation less than 30″ and, within this limit, picked up 2953 pairs. All pairs with a separation less than 10″ in zones 64° to 69° have been remeasured at Greenwich on old and new plates in order to obtain more trustworthy material, and it is planned to extend this work to the other zones. The photographic magnitudes have been determined, and the proper motions in these zones are also being investigated. Full particulars will be given in the catalogue, the first part of which will soon be published. The magnitudes are somewhat mixed in value. Down to $9^{\mathrm{m}}\cdot0$ the probable error should be just under $0^{\mathrm{m}}\cdot1$. From $9^{\mathrm{m}}\cdot0$ it might be put at $0^{\mathrm{m}}\cdot2$, and after $12^{\mathrm{m}}\cdot0$ the magnitudes given are little more than indications. The distances may be trusted not to differ more than 1′ from the true value. The magnitude corrections to be applied to the catalogue values are rather large, therefore, the statistics, so far as they bear on magnitude, are confined to the material from zones 64° to 69°. The results are tabulated. E. F.

1210. Distribution of Stars of Known Parallax. R. A. Sampson. *Roy. Astron. Soc., M.N.* 88. *pp.* 56–79, *Nov.*, 1927.

Following on a previous paper [see Abstract 2302 (1926)], the present contains the outcome of an investigation of the distribution of the stars as shown by a collection of spectroscopic parallaxes. Such a collection appears particularly suitable for disposing of matters of opinion and judgment, for it includes so large a proportion of all the stars down to the 6th magnitude that questions of selection do not enter. From the 7th magnitude onwards it becomes partial, and later strongly selective, and is, therefore, impossible to use demonstratively, but it is complete, for practical inferences, over most of its field. The conclusions from the examination are chiefly remarkable because they are direct and certain as far as they go. With reasonable closeness the number of stars per million cubic parsecs can be inferred for each spectral type and each absolute magnitude at a succession of distances from the sun. The information attains a certain point definitely and then breaks off. The results are set forth in numerous tables, which should be consulted in the original. Briefly, they lead to a withdrawal by the author of his previous conclusions. E. F.

1211. Henry Draper Extension. Annie J. Cannon. *Harvard Coll. Obs., Annals*, 100. *No.* 3. *pp.* 38–48, 1927.

The spectra of 5000 stars are given, of which 800 continue the classification in the Aquila-Sagitta region of the Milky Way. The remaining pages give the spectra of fainter stars between 50° and 54° North Declination, compiled from the Cambridge (U.S.) Catalogue. Attention is drawn to peculiarities in twenty-six stars. [See also Abstract 943 (1927).] A. S. D. M.

1212. Triple System, λ Tauri. P. Slavenas. *Nat. Acad. Sci., Proc.* 13. *pp.* 833–837, *Dec.*, 1927.

The author describes Schlesinger's discovery of a third body of period $(P_1) = 34\cdot60$ days, revolving round the spectroscopic eclipsing pair of period $(P) = 3\cdot9529452 \pm 34$ days; and points out that the most important perturbation is the motion of periastron of the close pair in a period (U), which can be expressed in terms of P, P_1, and $k(\equiv m_0/(m_0 + m_1 + m_2)$; and that the effect of the non-spherical shape of the two bodies is negligible in this expression. But as some of the observational material used by Schlesinger lie within the time of eclipse, and, therefore, the values of e and $\hat{\omega}$ should be ignored, the author employs McLaughlin's method [see Abstract 2943 (1924)], and finds that the absolute visual magnitude of the whole system $= -3\cdot14$; the parallax $= 0''\cdot0042$; $P = 3\cdot4529$ days; $P_1 = 34\cdot60$ days; $U = 14\cdot8$ years; the mass of the bright star (m_0) $= 13\cdot8\odot$, of eclipsing satellite (m_1) $= 2\cdot8\odot$, of distant satellite (m_2) $= 0\cdot9\odot$; the radii of the eclipsing pair in terms of the sun (radius $= 1$) are $8\cdot0$ and $6\cdot0$ respectively, and the distance between them $= 26\cdot7$; and their densities are $0\cdot027$ and $0\cdot013$ in terms of the sun's density.

A. S. D. M.

1213. Balance of Radiation in the Stars. E. Hopf. *ZS. f. Phys.* 46. 5–6. *pp.* 374–382, 1928.

The theory of E. A. Milne as to the balance of radiation in the atmosphere of the stars with the integral equation given by him is discussed. Especially a proof is brought forward that it possesses a strict null solution, *i.e.*, that equilibrium of radiation in the atmosphere of the fixed stars is possible. Moreover, attention is drawn to the connection with the older theorems of K. Schwarzschild. J. J. S.

1214. Optical Dissymmetry of Space. E. Esclangon. *Comptes Rendus*, 185. *pp.* 1593–1595, *Dec.* 27, 1927.

Observations are described which appear to show an optical dissymmetry of celestial space. J. J. S.

1215. Methods and Applications in Spectrophotometry. Cecilia H. Payne and F. S. Hogg. *Nat. Acad. Sci., Proc.* 14. *pp.* 88–93, *Jan.*, 1928.

Results of two years' experiments of standardisation of photographic spectrophotometry by the Moll microphotometer at Harvard. The two fundamental measures of stellar spectrograms—the absorption at any wave-length as compared with the neighbouring continuous background, and the relative background energy as compared with that of a star of known energy distribution, both measures being made at the same wave-length—are made differentially. It is found that one reduction curve, relating increase of blackening to increase of intensity, can be used for the whole length of the spectrum on each plate. The authors tabulate seven methods for obtaining the reduction curves. After calibration, the significant quantities taken for measurement are the blackness and total absorption of the lines, and the relative energy distribution in the continuous background. The results are summarised in a table, and those for the eight brighter Pleiades, Mira Ceti and the Wolf-Rayet stars are discussed briefly. The Saha-Fowler-Milne theory is put on a quantitative basis, so that it becomes possible to develop a theory of atmospheric structure. It is found that the total absorption of all lines is greater for intrinsically bright stars, and that contours are flattened for faint stars. A. S. D. M.

LIGHT.

1216. Absorption of Ultra-Violet Light by Glucose, Levulose and Lactose. L. Kwieciński and L. Marchlewski. *Acad. Polonaise Sci. et Lettres, Bull. No. 7a. pp.* 379–394, *July*, 1927.

Observations were made on the absorption for a large number of wave-lengths, with preparations of different degrees of purity. In the case of glucose the nominally pure product gave an absorption curve with an indication of a band at about 2800 Å.; but after it had been recrystallised six times from 96 % alcohol the absorption was greatly reduced, and the curve became a perfectly smooth one. Pure lactose also gave a smooth curve; this behaviour agrees with that previously observed for *d*-galactose, *d*-fructose or levulose, even when very carefully purified by crystallisation, shows a band, the maximum of which is at 2800 Å., in agreement with the results of Purvis. It seems, however, that for this substance the crystallisation process does not produce absolute purity, and the band may be due to traces of impurities. H. N. A.

1217. Measurement of Light-Absorption. H. v. Halban and J. Eisenbrand. *Z. wiss. Phot.* 25. *pp.* 138–152, *Feb.*, 1928.

The factors of the different methods critically discussed. In the photographic method there is an absolute, not a relative, error. If the extinction be sufficiently great, it can be determined by the photographic method within a few units per cent.; but the method is not adapted to small extinctions or small differences of extinction. It is well adapted to quantitative examination of absorption spectra. The photoelectric method presents no lower limit of error. It is well adapted to small extinctions or to small differences of extinction, not well to absolute measurements. For absorption spectra the number of lines serviceable is limited. The great differences between the results of the two methods with wave-lengths below 300 $\mu\mu$ are due to systematic errors in the photographic method. There are great and as yet unexplained differences between different photoelectric cells in respect of the relation between sensitiveness and wave-lengths. A. D.

1218. Spectrophotometric Observations on the Growth of Oxide Films on Iron, Nickel and Copper. F. H. Constable. *Roy. Soc., Proc.* 117. *pp.* 376–388, *Jan.* 2, 1928.

Reference is made to an earlier work on the colours shown during the oxidation of activated copper films supported on china clay [see Abstract 3075 (1927)]. In this paper the secondary factors such as the dispersion of the metallic oxides, their specific absorption and the variation in the intensity of the light absorbed by the metallic reflector at the back of the film with the wave-length of the incident light which produce modification in the colour sequence are considered for the growth of oxide films on thin films of iron, nickel and copper supported on china-clay rods and also on massive rods of these metals. J. K.

1219. Colorimetric Notation. S. Rösch. *Phys. Zeits.* 29. *pp.* 83–91, *Feb.* 1, 1928.

Two methods of describing a colour are (1) by dominant wave-length and purity or saturation, (2) by the percentage of the red, green and blue components in the matching mixture. The author describes a third method. Every light can be matched both in colour and intensity by means of either (*a*) a continuous portion of the spectrum of equal intensity throughout, or (*b*) an equal intensity spectrum from which has been removed a continuous portion. The wave-lengths of the ends of the portion required in case (*a*), or of the ends of the portion removed in case (*b*), provide two parameters for the description of the colour. Alternatively the length of the portion of the spectrum and the wave-length of its centre point may be used. These two parameters, together with the value of the spectral intensity required, give a complete description of the light both as regards colour and intensity. The application of the method to the practical description of dyes, etc., is described, and an instrument suitable for the purpose is illustrated diagrammatically. J. W. T. W.

1220. Visual Contrast and Precision of Measurement. A. Kühl. *Phys. Zeits.* 29. *pp.* 1–34, *Jan.* 1, 1928.

The author treats the problem of the precision attainable by the eye in making a measurement which depends on the determination of the position of the "edge" of an image produced by an optical instrument. Two factors reduce the precision of a setting of this kind: (*a*) the diffraction bands produced by the optical system of the eye itself; (*b*) the contrast bands, *viz.*, a dark band on the lighter part of the field and a light band on the darker part. These two effects are investigated separately, and observations are recorded on images of various kinds. The application of the results in astronomy, microscopy, etc., is discussed in some detail, and a bibliography of the subject is appended. J. W. T. W.

1221. Resolution of Gratings by the Astigmatic Eye. J. R. Hamblin and T. H. Winser. *Optical Soc., Trans.* 29. 1. *pp.* 28–39; *Disc.*, 39–42, 1927–1928.

An investigation on the resolution of gratings by the human eye, commenced by H. H. Emsley in 1925 [see Abstract 707 (1926)], was continued. The irregular curve representing variation of grating acuity from meridian to meridian was found to be of the same general form in all astigmatic eyes. Experiment showed that the image, produced by an ordinary astigmatic system, of gratings placed in various directions shows irregularities of the same form due to overlapping of the blurred images of the separate lines of the grating. Thus, an eye with regular astigmatism will exhibit irregularities in its capacity to resolve gratings at various inclinations, and charts consisting of fine parallel lines are not reliable in testing ocular astigmatism. AUTHORS.

1222. Phenomenon of Broca and Sulzer in Foveal Vision. W. H. Stainton. *J.O.S.A. and R.S.I.* 16. *pp.* 26–39, *Jan.*, 1928.

Experiments are described in which the brightness of the outer ring of a photometric field is determined, such that when the central field is flashed at a given brightness and for a given small interval of time (0·01 to 0·5 second), the two parts of the field appear equally bright. In this way, for a given physical brightness of the centre field, the apparent brightness is determined as a function of the duration of the flash. Contrary to earlier work on the same lines by Broca and Sulzer, and Kleitman and Piéron, it is found that different spectral colours and white light all give similar results.

The critical duration of flash such that the apparent brightness is the same as the equilibrium brightness B_{EQ}, obtained by normal photometric balance with the centre field permanently on, is found to be given by the formula $T_{cr} = \left[\left(\frac{B_{EQ}}{1\cdot 47}\right)^{\cdot 6} + 6\right]^{-1}$ (B_{EQ} in photons). This result is independent of the colour of the light. The ratio of the maximum observable apparent brightness to the equilibrium brightness is also given by a relation independent of the colour. The most important conclusion is that the rise of visual sensation is primarily a function of intensity and not of wave-length.

W. S. S.

1223. Repetition of the Harress Experiment. B. Pogány. *Ann. d. Physik*, 85. 2. *pp.* 244–256, *Jan.* 25, 1928.

The author describes an improved form of apparatus arranged to eliminate aberration. Tests were made with thick glass tubes containing various liquids and placed in the path of the interfering beams of light; but the results were inconclusive. Further tests were made using glass only, the fringes obtained being recorded photographically. The experimental results obtained are set out in the paper. The mean values were found to agree with the theoretical results to 1 %. [See also Abstract 2059 (1926).]

R. S. R.

1224. Plane Waves of Light. Part II. T. C. Fry. *J.O.S.A. and R.S.I.* 16. *pp.* 1–25, *Jan.*, 1928.

The author continues the discussion of Part I [see Abstract 85 (1928)], dealing in particular with the general cases of reflection and refraction at a plane surface separating two media, dielectric or metallic. W. S. S.

1225. Indices of Refraction and Rotatory Power of Crystals of Sodium Rubidium Tartrate. S. Kozik. *Acad. Polonaise Sci. et Lettres, Bull. No.* 4–5*a. pp.* 229–236, *April–May*, 1927.

The compound $NaRbC_4H_4O_6, 4H_2O$, crystallises in the orthorhombic system $a : b : c = 0\cdot 8332 : 1 : 0\cdot 4319$, and has the density 2·025 at 16° C. The refractive indices for the D line are 1·4909, 1·4948 and 1·4975, and the optic axial angle is 50° 23′; but values are also given for the refractive indices and optic axial angle for eight other wave-lengths in the visible spectrum. The rotatory dispersion in the visible spectrum is normal. The dispersion-ratio a_{4358}/a_{5461} is 1·615 for aqueous solutions, but only 1·485 for the crystal. The specific rotation of the crystals (measured along one of the optic axes) is four times as great as for the solution, but the difference in the dispersion-ratios appears to be within the limits of experimental error, with the possible exception of the difficult mercury violet line.

T. M. L.

1226. Determining the Refractive Index of Fused Salts. O. H. Wagner. *Zeits. phys. Chem.* 131. *pp.* 409–441, *Feb.*, 1928.

The author modifies the apparatus of Heck [see Abstract 1800 (1922)] to avoid corrosion of the mirrors placed in the salt. The crucible consists of a disc of quartz glass, 2·5 mm. thick, 5 cm. diameter, and a quartz tube, fused to it. A semicircle of the same transparent material, likewise fused on, half-closes the top of the crucible which fits into the tubular furnace. The furnace is covered by a threaded cap and can be tilted slightly (2° maximum) by the aid of a frame and a micrometer screw; the whole rests on three pillars. On the cap, which is provided with a plane parallel quartz window, is horizontally mounted a collimator tube; the light from the source passes through the collimator, is reflected by a prism through a slit in the window and down into the furnace, and reflected back again by the bottom plate. In use the furnace is tilted to a measured angle, heated up by its nichrome coil, charged with the preheated salt, and tilted again until the ray, now passing through the melt, is once more reflected back. The angle of the liquid prism is determined by the level of the liquid and the bottom plate. Six wave-lengths are used, 0·671 to 0·436 μ. Of the salts tested, the nitrates of the alkali metals, of silver and thallium, some chlorates, AgCl, etc. (first group), did not corrode the quartz when heated considerably above their melting points. $NaWO_4$, alkali halides, etc., did attack the quartz; the tungstate was examined in an apparatus of the Heck type with a platinum mirror. Tests take from three to eight hours. The refractive index always decreases as the temperature, measured by a thermocouple, rises. The negative temperature coefficient is smaller than, or equal to, the diminution of the index due to the decreased density of the fused salt in the first group, not for the tungstate. The difference between temperature coefficient and diminution of refractive index (due to the diminished density) is ascribed to the effect of absorption, which lies in the ultra-violet for the first group and in the infra-red for the tungstate; the latter has an absorption band near 1·777 μ. The absorption shifts more into the long-wave range at high temperatures. These distinctions are based upon the absorption studies of fused salts by Retschinsky [see Abstract 1944 (1908)]. Atomic refractions are also deduced. H. B.

1227. Theory of the Optical and Electrical Properties of Liquids. C. V. Raman and K. S. Krishnan. *Roy. Soc., Proc.* 117. *pp.* 589–599, *Feb.* 1, 1928.

The inadequacy of existing theories to explain the variations with density and temperature of the refractive index and dielectric constant is pointed out, and a new theory developed assuming the molecules of the fluid to be optically and electrically anisotropic, and the polarisation field acting on a molecule in a dense fluid to vary with its orientation relatively to the external field. Investigations on light-scattering furnish evidence for these assumptions and enable the anisotropic constants to be evaluated. The theory is successful in explaining why, in general, an increased density causes a diminished molecular refractivity as calculated from the Lorentz formula. W. S. S.

1228. Physical Optics. Report of Progress Committee, 1926–1927. *J.O.S.A. and R.S.I.* 16. *pp.* 44–61, *Jan.*, 1928.

The paper provides a summary of a large amount of original work published during the last three years in various branches of physical optics. R. S. R.

1229. Images with Inclined Mirrors. T. Oryng. *Phys. Zeits.* 29. *pp.* 41–42, *Jan.* 1, 1928.

The author deals with the general case such that $360/\alpha = n + p$, where α is the angle between the mirrors, n is an integer and p a fraction. For $p = 0$ two cases exist: (1) n even, the number of images is $(n - 1)$ if the source of light is on the bisector of the angle between the mirrors, but otherwise the number is n. For $p > 0$ the number of images is n or

$(n + 1)$, depending upon the position of the object. Assuming that $180 - m\alpha = \beta$, where m is a whole number, then for $\beta > \alpha/2$ the region for $n + 1$ images lies centrally and that for n images in the outer part of the space between the mirrors, while the reverse holds for $\beta < \alpha/2$. R. S. R.

1230. Construction and Tests of a Special Form of Pyrex Glass Telescope Mirror. A. Couder. *Comptes Rendus,* 186. *pp.* 311–313, *Jan.* 30, 1928.

The mirror consists of a shallow, cylindrical, dish-shaped piece of glass with a thick " wall " and a thin flat " bottom," the external face of which is ground to form a paraboloid. This thin disc of glass is supported all round by the ring of thick glass, which is supported at three points. The disc quickly takes the temperature of the surrounding air, and since it is made of pyrex glass the changes in its dimensions and the resulting distortions are small. The author has investigated mathematically the effect of the weight of the disc in causing distortion in different positions, and finds that a small change in focal length is to be expected when the telescope is moved from the horizontal to the vertical position, but that the deformation of form is too small to produce any optical effect. Tests with a mirror of 19 cm. diameter confirmed this. The weight of the mirror was about one-third of that of the ordinary disc mirror which it replaced. H. N. A.

1231. Lens Interferometer. G. C. Steward. *Cambridge Phil. Soc., Proc.* 24. *pp.* 166–170, *Jan.*, 1928.

Treats mathematically the instrument described in a paper by F. Twyman [see Abstract 830 (1922)], in which the Michelson interferometer is adapted for determining the aberrations of a lens or system of lenses and measuring their magnitude. A modification due to T. Smith makes it possible to test any object point, the incident wave being no longer plane but spherical, and the finally emergent wave a distorted portion of this sphere. Discusses the form of the interference patterns due to the different aberrations, and shows how the amounts of these aberrations can be determined from measurements of the bands. H. N. A.

1232. Determination of Cardinal Point and Width of Image from Photographs. A. Hornoch. *Zeits. Instrumentenk.* 47. *pp.* 579–583, *Dec.*, 1927.

Theimer [see Abstract 2019 (1927)] has shown how, under certain circumstances, the position of the cardinal point and the size of the image width can be obtained from photographs. The present paper, which is of a mathematical nature, deals with a solution of this problem. A. E. G.

1233. Experiments in Ultra-Violet Refractometry. L. C. Martin. *Optical Soc., Trans.* 29. 1. *pp.* 1–19; *Disc.*, 19–21, 1927–1928.

The experiments described have for their object the application of critical angle methods for the refractometry of liquids in the ultra-violet. A thin film of liquid can be held between two quartz hemispheres which are traversed centrally by an approximately parallel beam; the film receives the radiation at the varying angles of incidence resulting on rotation of the system. In this way, analysing the transmitted radiation with the aid of a quartz spectrograph, the critical angles for definite wave-lengths are measured, from which refractive indices can be calculated. The procedure necessary in seeking precise results is discussed, and a series of measurements on glycerine-water mixtures likely to be useful for immersion fluids in ultra-violet microscopy is given. A set of interesting phenomena of the extinction bands is described and explained. AUTHOR.

1234. Theory of the Refractometer. H. Schulz. *Zeits. Instrumentenk.* 48. *pp.* 26–30, *Jan.*, 1928.

In those instruments where the refractive index of a liquid is measured using a total reflection method it is advantageous to have, if possible, a linear relation between the index and the angle of emergence of the light from the prism. The present paper shows how, by a suitable choice of angle for the prism, this object can, over certain ranges, be accomplished approximately. A. A. D.

1235. Construction of Wave-Length Scales for Spectrograms. G. Barr. *Optical Soc., Trans.* 29. 1. *pp.* 22–24; *Disc.*, 24–27, 1927–1928.

A method is described by which an approximate scale of wave-lengths may be projected geometrically from a uniformly divided scale on to a spectrogram whereon a sufficient number of lines have been identified to enable constants of a Hartmann interpolation formula to be derived. Such a scale is of value in assisting the recognition of other lines between which accurate interpolation may be required. AUTHOR.

1236. Chromatic Aberration. R. Gans. *Phys. Zeits.* 29. *pp.* 43–46, *Jan.* 1, 1928.

The author explains an experimental method used for the determination of chromatic aberration in lens systems, employed formerly by Hartmann and used now also for a comparison of the chromatic corrections of different objectives. A theoretical treatment is given for the degree of achromatism to be expected with different kinds of glass.

R. S. R.

1237. Grating Method. Procedure for Demonstrating and Measuring Spherical Aberration. F. Jentzsch. *Phys. Zeits.* 29. *pp.* 66–72, *Jan.* 15, 1928. *Paper read before the Deut. Physikertag, Kissingen, Sept.*, 1927.

The condenser is moved away from the arc lamp of a projection apparatus till a real image of the crater is formed at some distance from the condenser. A circle of light, not uniformly bright and with a coloured margin, then appears on the screen. If now a coarse grating of about five wires per centimetre be held between the image of the crater and the wall, shadow bands are seen on the screen which are geometrically similar to the lines of the grating, *i.e.*, straight and equidistant. On moving the grating closer to the crater image the shadow bands become fewer, broader and wider apart, especially those in the vicinity of the optical axis. Fixing the grating so that the axis passes through the middle of a transparent part of it, the bands at the centre of the shadow image are forced asunder till, on further moving the grating towards the source of light, there appears at the centre a patch showing approximately circular illumination. In order to visualise clearly the various phenomena produced by altering the position of the grating, the illustrations, of which eleven are given, should be examined. The author claims for his procedure that it is simpler than the apparently very similar methods of Ronchi and Lenouvel. The paper is partly mathematical. [See next Abstract.] E. F.

1238. Tests of Optical Systems with "Rasters." G. Schulz. *Ann. d. Physik*, 85. 2. *pp.* 189–243, *Jan.* 25, 1928.

The author describes a method by which the spherical aberration of converging lens systems can be found qualitatively or quantitatively with the help of fringes produced by a special type of grating, the so-called "Raster." Three types of curves are produced in cases of aberration and having a coefficient of characteristic form. The apparatus used is described very fully, being simple in construction and easy to handle. From the formulæ obtained a sufficient number of points on the aberration curve can be found without difficulty. The interference fringes produced on the photogram with the help of this screen give a considerable increase in the accuracy of measurement. The author describes and explains a number of refraction phenomena. The method is limited to systems of not too small an aperture and is especially useful for the examination of individual convex lenses, photographic lenses and smaller telescopic objectives. With the investigation of the positions of the corrections a test can confirm readily the positions of flaws or streaks in the glass. R. S. R.

1239. Automatic Adjustment for a Concave Grating. A. Cotton. *Comptes Rendus*, 186. *pp.* 192–196, *Jan.* 25, 1928.

An arrangement of levers is proposed which will set the grating and photographic plate in correct relative positions for various orders of spectra. Such an arrangement can take the form of a lazy tongs, the length of one lever being a simple sub-multiple, say one-sixth, of the radius of curvature of the grating. F. S.

1240. Interference between Grating-Ghosts. S. Fagerberg. *Phil. Mag.* 5. *pp.* 204–208, *Jan.*, 1928.

Examination of the third-order spectrum obtained with a Rowland plane grating shows the single spectrum line Fe $\lambda = 4384$ T.A. has, beside the principal line, fainter lines (ghosts) of the same wave-length as the principal line and symmetrically located about it. With a slit placed in the focal plane and opened in turn wide enough to transmit (1) the principal line, (2) the ghost of the first order, (3) the principal line and the first-order ghost, (4) the principal line and ghosts of the first and second order, and (5) the principal line and the four ghosts, a series of interference patterns result. These have been recorded photographically, and calculations of the wave-length from these patterns agree well with theory. R. S. R.

1241. Interference of Light in a Wedge. F. L. Arnot. *Cambridge Phil. Soc., Proc.* 24. *pp.* 150–165, *Jan.*, 1928.

Describes an experiment in which light from a small sphere, about 2 mm. in diameter, rendered incandescent by a continuous arc between the sphere and a wire, is reflected at 45° by a thin wedge into the collimator of a spectroscope; interference bands are observed when the thick end of the wedge is towards the source, and the slit of the spectroscope is placed at a certain definite distance from the wedge. With a large source, such as the above, the slit receives rays from many different points in the wedge. Each ray produces a complete set of interference bands in the spectrum; these are in general irregularly displaced with regard to one another, but in the case mentioned above the path difference for the interfering components of all rays is the same, bright bands are superimposed on bright bands and dark bands on dark ones. With a point source the bands are observed whichever end of the wedge is towards the source, and for all angles of incidence and distances between wedge and slit. Mentions a possible advantage in using an air wedge in place of parallel plates for spectroscopic purposes. H. N. A.

1242. Stationary Value of Axially Symmetric Functions. Part II. T. Smith. *Optical Soc., Trans.* 28. 5. *pp.* 285–296, 1926–1927.

Alternative methods to those described in Part I [see Abstract 978 (1927)] of constructing a series representing the stationary value of a given function are developed and applied to evaluate all the terms not involving powers and products of the coefficients of the function higher than the eleventh. The formula in its optical applications enables the first 451 monorythmic aberrations of a symmetrical optical instrument to be determined. AUTHOR.

1243. Measurements of Radii of Lenses. A. Schleiermacher. *Zeits. Instrumentenk.* 48. *pp.* 70–74, *Feb.*, 1928.

Particulars are given of two methods which may be employed for the measurement of the radii of curvature of lens surfaces. In the former the observing apparatus is adjusted until it is at a distance from the surface equal to the radius of curvature as is shown by rotation, while in the latter a method of auto-collimation is used. The first method has the advantage of a simple measurement, but the apparatus is not easy to manipulate, while with the second the reverse holds, the calculation being troublesome. Both methods give results with an error not exceeding 0·05 %. R. S. R.

1244. Influence of Weak Magnetic Fields on the Degree of Polarisation of the Light Emitted by Hydrogen Canal Rays. H. R. v. Traubenberg. *Phys. Zeits.* 28. *pp.* 856–857, *Dec.* 1, 1927. *Paper read before the Deut. Physikertag, Kissingen, Sept.*, 1927.

Magnetic fields of measurable magnitude were orientated in various ways with regard to the direction of the hydrogen canal rays and the direction of vision. With the magnetic field along the direction of vision and (1) perpendicular to the canal rays the rotation of the plane of polarisation increases with weak magnetic fields to a maximum of about 30°, and depolarisation also increases; (2) with transverse magnetic fields little rotation of the plane of polarisation occurs, but there is important depolarisation. When the directions of the canal rays and of vision coincide, transverse magnetic fields produce polarisation, and there is a temporary accommodation of the degree of polarisation of the oscillator to the external field. The rotation and degree of depolarisation can be measured, and the theoretical results agree well with experiment. Assuming a magnitude for the damping constant, it is possible to calculate the damping force or the mean free path of the light disturbance for excited canal-ray carriers. R. S. R.

1245. Molecular Dispersion of Light on Hg Surface. M. Leontowitsch. *ZS. f. Phys.* 47. 3–4. *pp.* 299–300, 1928.

Theoretically the dispersed light is elliptically polarised [see Abstract 99 (1927)], but the ellipticity is so small that the plane polarisation of Raman and Ramdas is practically correct. [See Abstracts 2268 and 2677 (1925).] A. D.

1246. Properties of Powders. Scattering of Light by Graded Particles in Suspension. T. M. Lowry and M. C. Marsh. *Faraday Soc., Trans.* 24. *pp.* 195–201, *March*, 1928.

The scattering of light by ground barytes of different degrees of fineness was studied. The sample of barytes was ground and separated into thirteen fractions by elutriation at water velocities of 0·5 to 12·5 mm. per second. The diameters of the particles were measured and the validity of Stoke's law was tested with these samples of barytes. The various fractions were suspended in medicinal paraffin and the light transmission was measured. The optical density was found to be proportional to the surface concentration of the powder, but it increased slowly as the diameter was reduced to 50 μ, and much more rapidly when the diameter was reduced below 30 μ. A maximum degree of opacity probably exists on further subdivision. F. J. B.

1247. Arrangement for Showing by Maps Inclined Landscapes Taken from the Air. C. Aschenbrenner. *Zeits. Instrumentenk.* 47. *pp.* 568–579, *Dec.*, 1927.

The geometrical problem underlying this method is discussed in detail, so that in the main this paper is of a mathematical nature. The necessary degree of freedom is discussed, as is also the application of the new method to existing forms of procedure. A. E. G.

1248. Photographic Surface of Densities. H. Arens and J. Eggert. *Zeits. phys. Chem.* 131. 3–4. *pp.* 297–309, *Jan.*, 1928.

By combining various intensities with various times a surface of densities is set up of which log i and log t are taken as ordinates. The form of the surface depends on the relation between log i and log t, having regard to Schwarzschild's exponent p. Practical experimental example. A. D.

1249. Optical and Photographic Properties of a Series of Typical Cyanine Dyes. O. Bloch and F. M. Hamer. *Phot. J.* 68. *pp.* 21–33; *Disc.*, 34, *Jan.*, 1928.

The photographic action of a complete series of typical simple cyanine dyes (ethiodides) is described. Starting with 1 : 1′-diethylpseudocyanine iodide, which contains two quinoline nuclei, linked together at the 2- and 2′-positions by means of a methylene group, replacement of the 2 : 2′- by the 2 : 4′- and then by the 4 : 4′-linking is accompanied by displacement of the maxima of the absorption spectra towards the red. This shift of the absorption corresponds with the lengthening in the carbon chain connecting the two nitrogen atoms. A similar shift is produced in the same way in the carbocyanines, in which the quinoline nuclei are connected by the chain : CH · CH : CH ·, and comparison of the spectra of these two classes of compounds indicates that, if the nuclei were joined by a five-carbon chain, the resultant dyes would exhibit absorption in the deep red and infra-red. Similarly, with the thiocyanines, containing one benzthiazole and one quinoline nucleus, displacement of the absorption towards the less refrangible region occurs on replacement of a 2- by a 4-linking. Replacement of the quinoline nuclei by indolenine nuclei to give indocarbocyanine causes the absorption region to move towards the blue, and this effect is still more marked when the quinoline nuclei are replaced by benzoxazole nuclei to form oxacarbocyanine. The indo- and oxa-carbocyanines exhibit sensitising properties, and, with the exception of thiocyanine, every type of cyanine dyestuff tested behaves as a photographic sensitiser. Neocyanine, a dye of unknown constitution, furnishes plates sensitive into the far infra-red, and indopseudocyanine, with a substituted indolenine nucleus and a quinoline nucleus with a 2-linking, confers slight sensitivity. T. H. P.

1250. The Latent Image. A. P. H. Trivelli. *Eastman Kodak Co. Research Lab. Comm. No.* 313. *Phot. J.* 68. *pp.* 67–72, *Feb.*, 1928. *Frank. Inst., J.* 205. *pp.* 111–122, *Jan.*, 1928.

Based on the theoretical conclusions of Wightman and Quirk in their investigations on the action of H_2O_2 on high-speed plates and of Clark's experiments on the action of oxidisers on sensitivity and the latent image, which indicate that the sensitising speck of high-speed photographic emulsions, as well as the latent image, probably consists of both silver and silver sulphide, a probable elementary photoelectric cell on the surface of the silver halide grains can be pictured. A proposed mechanism of the action of this cell in producing sensitivity is described. Assuming that optical sensitising is due to an increase of the photo-conductivity for longer wave-lengths, a possible mechanism is given of how either certain dyes or silver sulphide could act as optical sensitisers to increase the sensitivity of silver halide for wave-lengths longer than the blue. This mechanism is based upon the assumption that dye specks, or finely divided silver, or silver sulphide, lying in the field of the photoelectric cell Ag–AgBr–Ag_2S, increases its photo-conductivity above that of such a cell, without one of these substances present, to wave-lengths longer than the blue. The range and intensity of the colour sensitivity are dependent, not only on the absorption of light of given wave-lengths, but also on the size and distribution of the specks of impurity. [See Abstract 618 (1928).] A. D.

1251. Fog Correction of Photographic Blackening. H. A. Pritchard. *Z. wiss. Phot.* 25. *pp.* 79–113, *Jan.*, 1928.

The Wilsey fog correction neglects some factors which have a marked influence in the case of slight fog. In the present paper experimental functions for fog correction are investigated. The Wilsey method of fog correction apparently gives satisfactory results on the assumption that the image-density can be completely developed before the fog reaches the value 0·5. It is found that it is possible by means of prolonged development to develop the whole of the silver present on the film as fog; still, the density of the maximum fog is considerably smaller than the maximum image density. The great variations in photometric equivalent contributes considerably to the failure of the Wilsey fog correction under extreme conditions. [See also Abstract 619 (1928).] A. E. G.

1252. Reduction of Latent Image. Lüppo-Cramer. *Z. wiss. Phot.* 25. *pp.* 129–133, *Feb.*, 1928.

Persulphate attacks most strongly the denser parts of a negative, Farmer's reducer the thinner parts. Bichromate attacks most strongly the denser parts of a latent image. All oxidisers and silver-dissolvers appear to do the same, provided there is at the same time a solvent for the silver halide adsorbed by the negative silver, in the absence of which the attack may be mainly upon the thinner parts. Persulphate promotes fogging, but not with bromide paper; H_2O_2 acts analogously, powerfully promoting fogging. The explanation is based upon this, that the last remains of adsorbed or solidly-dissolved substances are the most difficult to dissolve out. A. D.

1253. Catalytic Poisoning in Photography. Lüppo-Cramer. *Z. wiss. Phot.* 25. *pp.* 133–137, *Feb.*, 1928.

AgBr adsorbs dyestuffs; but negative silver adsorbs them also, and its catalytic action is thereby greatly enfeebled. Reduction by persulphate is hindered; by rhodamin B it is completely stopped. Whether the dyestuff be a sensitiser or a desensitiser the results are similar, and so whether the dyestuff be acid or basic. A. D.

1254. Photographic Diffusion Light Halos. R. Wildt. *Z. wiss. Phot.* 25. *pp.* 153–184, *Feb.*, 1928.

The discussion of the properties of the photographic emulsion as a turbid medium leads, on the hypothesis of Scheffer, to an integral which shows the laws of intensity decrease in the D-light halo. A strict solution of this integral is not possible. For great distances from the edge of the primary image the law of intensity decrease changes to the simple exponential function. For smaller distances the intensity function is always greater than the *e*-function. With the help of the photographic blackening law, a formula is obtained for the transition from a suitable intensity law to the corresponding diameter law of the D-light halos, and inversely from an empirical diameter law to the underlying intensity law. The diameter law of the D-light halo in monochromatic light is investigated with lighting times varying from 1 to 10^4 and beginning diameter of hole and slit images from 0·03 to 1·6 mm. The steepness of the diameter curve increases markedly with the wave-length of the light and slightly with the beginning diameter of the images. Increase of the turbidity factor, as found by Goldberg, with very intense exposure with white light, is explained by the innate sensitivity of the unsensitised plate for the green and red rays of the white light and is experimentally established. The determination of the turbidity factor is carried out for the four principal lines of the visible spectrum of Hg, as well as for an ultra-violet and an ultra-red spectrum region. A. E. G.

1255. A Comparitor Microphotometer. G. R. Harrison. *J.O.S.A. and R.S.I.* 16. *pp.* 63–67, *Jan.*, 1928.

Microphotometers are usually designed for automatic recording. The present writer has designed a comparitor microphotometer for manual and optical operation, automatic recording being of secondary importance. A further feature is that the intensity and the wave-length of any optical line can be read simultaneously. This also enables the exact centre of any spectral line to be determined accurately by the point of maximum intensity. The instrument, which employs an improved vacuum thermo-element, is described in detail with an illustration and a diagram of the optical system. B. J. L.

1256. Heterochromatic Photometry of Coloured Surfaces. K. Schaum. *Zeits. phys. Chem.* 131. 3–4. *pp.* 226–236, *Jan.*, 1928.

The first part of the paper contains a general discussion of the problem of photometry of coloured objects. Two forms of photometer are then described. The first is a modified form of Lummer-Brodhun head with chess-board field. The glass contrast plates cover respectively the upper and lower thirds of the field, so that the observer sees at the same time (*a*) light $A >$ light B, (*b*) light $A =$ light B, (*c*) light $A <$ light B. It is claimed that with this form of head an individual observer can repeat his values to within 1 % except for very great colour differences, *e.g.*, 1·3 % for red against green, and 2·2 % for green against blue. The second form of photometer is a modification of W. Ostwald's slit diaphragm photometer, the principle of $A > B$, $A = B$ and $A < B$ in a tripartite field being again introduced. J. W. T. W.

1257. Photo-Luminescence of Aesculine Solutions at Low Temperatures. J. Starkiewicz. *Acad. Polonaise Sci. et Lettres, Bull.* 8*a*. *pp.* 459–471, *Oct.*, 1927.

The luminescence was studied at room-temperature and also at − 12° C., − 80° C. and − 180° C. The solution was contained in a vessel immersed in a Dewar flask and a conical phosphoroscope arranged above. The spectra were photographed with a glass spectrograph of medium dispersion. The fluorescence bands are shifted to the violet as the temperature is lowered to − 80° C. A feeble green phosphorescence lasts a few seconds at this temperature. There is intense phosphorescence of longer duration at the temperature of liquid air showing maxima at 4800, 4950, 5150, 5400 and 5600 Å. F. S.

1258. Duration of Fluorescence of Solid Uranium Salts and of their Solutions. F. Perrin and R. Delorme. *Comptes Rendus*, 186. *pp.* 428–429, *Feb.* 13, 1928.

The luminescence of these salts has all the characters of a simple fluorescence with long duration; the very short-lived fluorescence measured by Pringsheim and Gaviola, if it really exists, is of little importance. The authors have used a phosphorometer consisting of a Becquerel disc phosphoroscope, combined with a Lummer photometer, and a disc with variable sector of opening to cut down the intensity of a comparison beam from the same source as that which produces the fluorescence. The intensity I of the light from the phosphoroscope was measured as a function of the time T of a complete revolution of the system of discs. The curve obtained is in accordance with an exponential law for the decrease of the luminous intensity with time, and makes it possible to obtain the value of τ, the mean life of an excited molecule. For the crystallised sulphate $\tau . 10^4$ in seconds was found to be 2·5; for the crystallised nitrate 6·1; two uranium glasses 3·2 and 2·9; solutions of anhydric uranium sulphate in pure sulphuric acid at 17° C., concentration (gm./cm.^{3}) $7{\cdot}2 \times 10^{-3}$, 1·4 (2·0 at 1° and 1·25 at 28°), concentration $7{\cdot}2 \times 10^{-2}$, 1·0, concentration $7{\cdot}2 \times 10^{-1}$, 0·9. The addition of water diminishes the mean life. H. N. A.

1259. Radiation Damping in Quantum Mechanics. F. Bloch. *Phys. Zeits.* 29. *pp.* 58–66, *Jan.* 15, 1928.

For a given atomic system, the author investigates how the square of the absolute amount of the wave function changes with time when the coupling with the radiation field is considered from the Dirac standpoint [see Abstract 2042 (1927)]. In general, a damping dispersion of wave packets is given which corresponds to that in the absence of damping. If, however, that solution of the wave equation for the special case of the harmonic oscillator for $t = 0$ be chosen, which furnishes the wave packets given by Schrödinger, then the damped harmonic oscillation is obtained which is demanded by the classical theory. H. H. Ho.

1260. Explanation of Some Spectral Properties on the Quantum Mechanics of the Rotary Electron. J. v. Neumann and E. Wigner. *ZS. f. Phys.* 47. 3–4. *pp.* 203–220, 1928.

In this paper the kinematic properties of systems of rotary electrons are derived from Pauli's conceptions of spinning electrons [see Abstract 2671 (1927)] by means of the Dirac-Jordan transformation theory. The results are shown to be applicable to optical spectra. H. H. Ho.

1261. Absence of Broadening of Spectral Lines after Reflection. Y. Rocard and P. de Rothschild. *Comptes Rendus,* 186. *pp.* 313–315, *Jan.* 30, 1928.

Considers the theory of the broadening of spectral lines owing to the thermal agitation of the reflecting atoms, which, owing to the Doppler-Fizeau effect, modifies the wave-length of the reflected light. The authors have caused a beam of light to be reflected by six or eight silvered mirrors successively at 45° before entering a Michelson interferometer. In the hope of increasing the velocity of thermal agitation of the diffracting atoms, experiments were made in which some of the silvered mirrors were replaced by polished aluminium ones. Various fine lines were employed, and the rings at infinity seen in the interferometer with large differences of path were compared with those produced by direct light suitably reduced in intensity by an optical wedge. No change in the visibility of the rings was observed. Calculations have shown that the method would have made evident 1/200 of the actual thermal energy if this had produced the expected Doppler effect. Suggests that either the diffraction of the waves by the atoms does not constitute the real elementary phenomenon, or that there is a kind of linking between neighbouring atoms so that their vibrations are synchronised. H. N. A.

1262. Continuous Emission Spectrum of the Discharge without Electrodes. G. Balasse. *Comptes Rendus,* 186. *pp.* 310–311, *Jan.* 30, 1928.

The emission process, which the author has proposed in a previous paper to explain the continuous spectrum observed when a discharge takes place without electrodes in Cd, K, Rb, Cs and Hg, makes it probable that a similar spectrum can be produced in all other elements. To test this experiments have been made with P, Bi, S and I. For P one spectrogram showed a weak continuous emission spectrum; Bi gave a continuous emission spectrum; S showed at least one such spectrum which corresponded to the passage $S \xrightarrow{+} S$ neutral. These elements, with those previously mentioned, fall in five different columns of the periodic table, and the author considers that he has proved that the phenomenon is a general one for all elements. This spectrum increases in intensity with the atomic number of the element and with the voltage of the discharge producing it. The author also deals with the relation between these spectra and certain lines of the emission spectrum, which is due to a phenomenon of anomalous dispersion in the interior of the lines. H. N. A.

1263. Intensity of " Prohibited Ray " of Potassium. F. Rasetti. *Accad. Lincei, Atti,* 6. *pp.* 54–55, *July,* 1927.

In the spectrum of atoms we have not all combinations of terms, but only those which satisfy determinate rules of selection of quantic numbers. These rules apply, however, only to the atom free from all external influences. Where, however, we have, say, an electric field, there are other rays which do not follow the rules; these are the "prohibited rays," which are comparatively feeble. Measurements have not succeeded in ascertaining the effects of pressure, but the coefficient of anomalous dispersion for prohibited rays of potassium has been estimated, and leads to the conclusion that there is only one dispersion electron for every one million atoms. A. D.

1264. Intensities of Forbidden Multiplets. J. Taylor. *Phil. Mag.* 5. *pp.* 166–172, *Jan.,* 1928.

Measurements were made upon the forbidden lines of potassium $1^2S - 3^2D_{5/2}$, $1^2S - 3^2D_{3/2}$ ($\lambda 4643{\cdot}172$ and $\lambda 4641{\cdot}585$). They were produced by a carbon arc fed with potassium carbonate, a mercury vapour lamp containing potassium, or an electrodeless discharge in potassium vapour, and photographed with a Rowland grating apparatus. Intensity measurements were made with a Moll microphotometer. It is concluded that the sum rule is valid for forbidden multiplets and that the relative intensity of forbidden to non-forbidden lines increases with current and vapour density. This accords with the hypothesis that ionic electric fields bring out the forbidden lines. F. S.

1265. Continuous Absorption of Light in Potassium Vapour. R. W. Ditchburn. *Roy. Soc., Proc.* 117. *pp.* 486–508, *Jan.* 2, 1928.

Experiments designed to measure the continuous absorption of light in the alkali-metal vapours are described. The absorption found is believed to be due to a combination of molecular and atomic absorption. The possibility of separating these is discussed. The results are examined in connection with the theory of atomic and molecular absorption. The amount of atomic absorption appears to be much less than that expected. An experiment in which continuous absorption produces line fluorescence is described and explained in connection with the molecular absorption. The heat of dissociation of the potassium molecule is derived from the absorption curves and used to calculate the degree of association in potassium vapour at different temperatures. A. E. G.

1266. Mechanism of Emission of Spectral Summation Series. A. T. Williams. *Univ. Nac. La Plata, Estudio Ciencias, No.* 77. *pp.* 115–124, 1927.

This paper deals with an analysis of the hypothesis of Hicks [see Abstract 2609 (1926)], according to which the process of emission of the lines of summation series should consist in the simultaneous neutralisation of doubly-ionised atoms—that is to say, that two quantum jumps necessary to produce the neutralisation of the atom, instead of originating two monochromatic radiations, would originate only one, the frequency of which would be equal to the sum of the frequencies corresponding to each jump. While this explanation, similar to that suggested by Russell and Saunders in 1925 for the anomalous series in the spectra of alkaline earths, obviates the difficulty caused by the establishment of new terms for the summation series, on the other hand it presents these others: (1) The Russell-Saunders hypothesis only applies to atoms having two electrons in their external orbit, and, therefore, does not apply to the atoms of Li, Na, K, Rb, Cs and Ag; (2) the said hypothesis is only considered valid in quantum jumps between the inner orbits; (3) the terms of the normal series of the arc would, in certain cases, belong to an ionised atom. It is considered that the hypothesis suggested by Hicks is not theoretically impossible. A. E. G.

1267. Wave-Lengths of Carbon, Oxygen and Nitrogen in the Extreme Ultra-Violet with a Concave Grating at Grazing Incidence. J. B. Hoag. *Astrophys. J.* 66. *pp.* 225–232, *Nov.*, 1927.

A vacuum spectrograph has been constructed with the use of a concave speculum grating of 215·3 cm. radius having 591 lines per mm. The familiar Rowland mounting is used except that the slit is placed close to the grating, making the angle of incidence approximately 80°. This results in high dispersion and resolving power. In the first order the scale varies from 3·64 Å. per mm. at 1700 Å. to 2·0 Å. per mm. at 300 Å. Wave-lengths for spark discharge through magnesium and carbon electrodes are given from 1658 to 558 Å. By flowing gases through the electrodes during the sparking, simultaneous gaseous and metallic spectra are obtained. AUTHOR.

1268. Spectrum of Doubly-Ionised Oxygen (OIII). A. Fowler. *Roy. Soc., Proc.* 117. *pp.* 317–330, *Jan.* 2, 1928.

The lines have been mainly observed with strong discharges in vacuum tubes, and photographed with a 10-ft. concave grating, or with a large quartz spectrograph. A catalogue of more than 300 lines is given, of which about one-half have been classified by the author and others. The spectrum is generally similar to that of NII, and the terms deduced are in complete agreement with Hund's theory. The term values are based on a sequence of three singlet D terms. The deepest term is of the type $^3P_0$, and for this the value 444661 has been found using Bowen's suggestion that the nebular lines λ5006·8 and λ4958·9 are due to combinations of deep terms of OIII. The corresponding ionisation potential of OIII is 54·88 volts. F. S.

1269. Spark Spectrum of Oxygen (OII). H. N. Russell. *Phys. Rev.* 31. *pp.* 27–33, *Jan.*, 1928.

Thirteen new terms in the OII spectrum have been definitely, and two more provisionally, identified, accounting for 99 lines, including all the strong ones not previously classified. The electron configurations corresponding to the new terms have been identified. Those in which the excited electron is in a 4*f* or 5*f* orbit give diffuse lines. Intercombinations between the doublet and quartet systems—detected independently by Croze and Mihul [see Abstract 363 (1928)]—confirm Bowen's conclusions regarding the origin of the nebular lines near λ3727 [see Abstract 1754 (1927)]. AUTHOR.

1270. Spark Spectrum of Neon. Part II. T. L. de Bruin. *ZS. f. Phys.* 46. 11–12. *pp.* 856–872, 1928.

This is a continuation of previous work [see Abstract 3125 (1927)]. The spectrum is strongly excited in a vacuum tube at a pressure of about 2 cm. The spectrum was photographed with a grating of 2-m. radius. The scheme of levels of the earlier work is extended to higher terms, and some strong lines arranged in a doublet system. An analogy is found in the grouping of the FII and NeIII lines. F. S.

1271. Secondary Standards of Wave-Length; Interferometer Measurements of Iron and Neon Lines. H. D. Babcock. *Mt. Wilson Observat., Contrib. No.* 343. *Astrophys. J.* 66. *pp.* 256–282, *Nov.*, 1927.

After some discussion of the technique, standard wave-lengths are given for 286 iron lines, λ3407–λ6677, and for eleven neon lines, λ5852–λ6506, measured in terms of the primary standard, λ6438·4696 of cadmium. The neon wave-lengths agree precisely with the values that have been adopted as secondary standards. Wave-lengths found for iron lines are systematically less than the adopted values, confirming results from other laboratories. From detailed comparisons it is concluded that the adopted system would be improved by a reduction of about 2 parts in 5,000,000 for wave-lengths less than λ5506, and by a linear reduction in the red region amounting to 5 parts in 6,000,000 at λ6200, and to 8 parts in 6,000,000 at λ6600. The systematic differences between the results of different observers are discussed and partially explained. A few additional wave-lengths obtained by the adjustment of earlier observations to the new scale are given, as well as supplementary wave-lengths, λ6213–λ7586, for 63 iron lines observed under arc conditions somewhat different from those specified for the production of secondary standards. AUTHOR.

1272. Series and Ionisation Potentials of the Elements of the Iron Group. H. N. Russell. *Mt. Wilson Observat., Contrib. No.* 342. *Astrophys. J.* 66. *pp.* 233–255, *Nov.*, 1927.

The recognition of the electronic configurations corresponding to the terms of complex spectra has made it possible to identify series (usually of two members only) in all the arc spectra from K to Zn, and in the majority of the spark spectra from Ca^+ to Zn^+. A Rydberg formula, applied to the first two terms, gives approximate series limits. These have been corrected by an empirical formula, which, in the fifteen cases where the test can be made, gives results differing from those of the more exact Ritz formula by an average of ± 0·5 %. Values of the first ionisation potential for all these elements, and of the second for all but V, Cr, Fe and Co, have thus been obtained. Approximate values for the latter have been derived with the aid of Moseley's law. For most of these elements there are four important modes of ionisation of the neutral atom, and three for the second ionisation, corresponding to changes between various metastable states (and still others are possible). Tables of the values of these important ionisation potentials are given. The principal ionisation potentials which measure the energy required for the change from the lowest energy state of the atom in one degree of ionisation to the lowest energy state in the next are K, 4·32 volts; Ca, 6·09; Sc, 6·57; Ti, 6·80; V, 6·76; Cr, 6·74; Mn, 7·40; Fe, 7·83; Co, 7·81;

Ni, 7·64; Cu, 7·69; Zn, 9·36; and for the second ionisation, Ca+, 11·82; Sc+, 12·80; Ti+, 13·60; V+, (14·7); Cr+, (16·6); Mn+, 15·70; Fe+, (16·5); Co+, (17·2); Ni+, 18·2; Cu+, 20·34; Zn+, 17·89. These values should be accurate to 0·1 volt or better, except those in parentheses, which have been derived by Moseley's law, and may be in error by as much as 0·3 volt. New high terms, arising from configurations involving a 5*s* electron, have been identified in the spectra of V, Mn, Co and Mn+. Tables of these terms and of the multiplets involving them are given. The ionisation potentials of V and Mn+ have thus been determined for the first time. [See also Abstract 650 (1928).] AUTHOR.

1273. Arc and Spark Spectra of Titanium. Part I. The Spark Spectrum, TiII. H. N. Russell. *Mt. Wilson Observat., Contrib. No.* 344. *Astrophys. J.* 66. *pp.* 283-328, *Nov.*, 1927.

A detailed analysis of the titanium spectrum aided by much unpublished material generously supplied by colleagues has led to the classification of practically all the lines except the weakest. The spark spectrum includes doublet and quartet terms; 33 doublet and 17 quartet terms have been identified. Their combinations give 164 multiplets, including 529 observed lines. The lowest energy-level belongs to a $^4F'$ term. A second $^4F'$ term is 0·1 volt higher, and a $^2F'$ term 0·5 volt above this. Tables of the terms are given, and also of the classified lines, including the few lines of any strength which remain unclassified. The temperature classification of the lines shows the usual close relation to their levels of origin. The Zeeman effect is in good agreement with Landé's theory. Tables of the observed and computed patterns are given. The electronic configurations in the atom which give rise to the various terms have been identified with the aid of Hund's theory. The agreement of theory and observation is complete. The complexity of the spectrum is explained by the numerous possible spatial orientations of the orbits of the three spectroscopically active electrons. Three series of two members each have been identified. They indicate an ionisation potential of 13·6 volts. Comparison of the spectra of TiII and ScI shows that Moseley's law is closely satisfied and confirms the theoretical interpretation of both. [See next Abstract.] AUTHOR.

1274. Arc and Spark Spectra of Titanium. Part II. The Arc Spectrum, TiI. H. N. Russell. *Mt. Wilson Observat., Contrib. No.* 345. *Astrophys. J.* 66. *pp.* 347-438, *Dec.*, 1927.

The arc spectrum of titanium is complicated. The identified terms include 43 singlets, 65 triplets and 34 quintets. Combinations between these give 422 multiplets and account for 1394 lines. There are many intercombinations between singlets and triplets, and between triplets and quintets, but none between singlets and quintets. The lowest term is a $^3F'$; next come a $^5F'$ and a ^1D. Tables of these terms and of the classified lines similar to those in Part I are given, and the methods employed in the analysis are illustrated. The temperature classification of the lines is again in agreement with their levels of origin, and the Zeeman effect accords with Landé's theory, except for a few terms with abnormal *g* values. Tables are given for more than 300 lines. Hund's theory accounts for the observed terms in a completely satisfactory manner. The electron configurations corresponding to most of them can be assigned with certainty, and for the rest with little ambiguity. Seventeen series have been identified which converge to seven different limits, all terms of TiII. The ionisation potential is 6·81 volts. Comparison of the spectra of TiI and VII shows the similarity of their structure, and indicates that the ionisation potential of VII is approximately 14·1 volts. [See preceding Abstract.] AUTHOR.

1275. Arc Spectrum of Antimony. S. L. Malurkar. *Cambridge Phil. Soc., Proc.* 24. *pp.* 85–88, *Jan.*, 1928.

The published values of wave-lengths have been used to find the nature of terms in this spectrum, which is analogous to singly-ionised oxygen investigated by Fowler. A table of expected lines is given, including some not yet observed. Three new lines have been found in the region of 2000 Å. F. S.

1276. Structure of the Cobalt Spectrum. Part II. M. A. Catalán. *ZS. f. Phys.* 47. 1–2. *pp.* 89–113, 1928.

This paper continues previous work [see Abstract 2092 (1925)] and describes new terms of the three group levels of the cobalt spectrum belonging to the doublet and quartet systems. By inter-combination of these terms, together with the known data, the author has classified more than 700 lines, so that in the cobalt arc about 1200 lines have been standardised. The deep terms belong to at least two different configurations of external electrons, d^7s^2 and d^8s^1, and are in agreement with the predictions of Hund's theory. H. H. Ho.

1277. Flame and Spark Spectra of Salt Solutions. W. Hirschel. *ZS. f. Phys.* 47. 1–2. *pp.* 147–150, 1928.

A modification of the sparking tube of Delachanel-Marmet is described, by which salt solutions can be introduced into a Bunsen flame, in known quantity, as fine drops. The apparatus can be used also for the production of spark spectra. Modifications are described for intense discharges. F. S.

1278. Absorption by Quartz and Air and its Components up to 1810 Å. A. T. Williams. *Univ. Nac. La Plata, Estudio Ciencias, No.* 77. pp. 95–114, 1927.

Some observers (*e.g.*, Bloch) hold that spectrographs submerged in air only allow passage up to 1854·67 Å.; others (*e.g.*, Fowler) that it is possible to reach 1841·25. The author finds the minimum λ that it has been possible to photograph, with air and nitrogen respectively, to be as follows: Hg arc lamp, 1849·57 and 1849·57; Al spark, 1854·67 and 1854·67; Fe spark, 1838·30 and 1830·52; Zn spark, 1839·80 and 1808·40; Cd spark, 1838·50 and 1823·70; Sn spark, 1854·90 and 1811·10; Ca spark, 1840·20 and 1838·00. It is, therefore, possible to have a nitrogen spectrograph (nitrogen 650 mm., quartz 43 mm.). The absorption of the Hg line $_1S - _1P$ depends upon the density of the vapour, which is directly proportional to the heating of the lamp, not to the voltage. Photographs of the different spectra. A. D.

1279. Absorption Spectra. R. G. Loyarte and Margarita H. de Bose. *Univ. Nac. La Plata, Estudio Ciencias, No.* 82. *pp.* 197–208, 1928.

Comparison of absorption spectra of yarba-mate and of its principal adulterants, caona, caneton and auta. Standardising an alcoholic solution of yerba-mate. A. D.

1280. Absorption Spectrum of Thallium Vapour. R. G. Loyarte and A. T. Williams. *Univ. Nac. La Plata, Estudio Ciencias, No.* 82. *pp.* 229–241, 1928.

The lowest level in the atom is 2^2P_1; in absorption appear the series $^2P_1{}^2S_1$ and $^2P_1{}^2D_2$; very few lines of 2^2P_2 level appear, contrary to the cases of Al, Ga, In. Compared with thallium, there are 3·5 times as many atoms at the 2^2P_2 level in indium, 9·4 times as many in Ga and 68 times as many in Al. Fine absorption lines observed between 2210 and 2105 Å. hitherto only seen as bands or as very diffused lines. A. D.

1281. Ultra-Violet Band System of Carbon Mono-sulphide and its Relation to those of Carbon Monoxide (the "4th Positive" Bands) and Silicon Monoxide. W. Jevons. *Roy. Soc., Proc.* 117. *pp.* 351–375, *Jan.* 2, 1928.

Reference is made to the work of Martin [see Abstract 2927 (1927)], the present author making more extensive measurements of the heads in Martin's spectrograms and to which he assigns vibrational quantum numbers *n′*, *n″*. The various observed anomalies are interpreted. It is found as regards three factors that the CO and SiO systems are more nearly alike than the CO and CS systems. J. K.

1282. Demonstration of Partial Frequencies in Light Waves of Periodically Varying Intensity. E. Rupp. *ZS. f. Phys.* 47. 1–2. *pp.* 72–88, 1928.

The everyday effect in the technique of electric oscillations of superimposing a modulation wave on a fundamental is here extended in a new manner to light waves. The light of the green thallium line is modulated by means of electric waves of wave-length from 100 to 24 cm. by the use of the Kerr effect, and the presence of partial frequencies is demonstrated by suitable apparatus, which includes a resonance lamp and an absorption tube containing thallium vapour. A. W.

1283. Series Spectra of Chlorine, Cl_{II}, Cl_{III}, Cl_{IV}, Cl_{V}, and of Si_{II}, P_{III} and S_{IV}. I. S. Bowen. *Phys. Rev.* 31. *pp.* 34–38, *Jan.*, 1928.

Twenty-six lines are classified in Cl_{II}, eighty-eight in Cl_{III}, twenty-six in Cl_{IV} and seventeen in Cl_{V}. Twenty-one term values are fixed in Cl_{III}. Five lines are identified in Si_{II} in addition to those previously known. Fifteen additional lines are classified in P_{III} and thirteen in S_{IV}. AUTHOR.

1284. Fluorescence of Mercury Rare Gas Bands. O. Oldenberg. *ZS. f. Phys.* 47. 3–4. *pp.* 184–202, 1928.

The question considered is whether an atom can be raised to a given excited state by the simultaneous acquisition of energy (*a*) from another atom in collision, (*b*) by absorption from the radiation field. The infrequency of triple collisions, two atoms and a light quantum, precludes direct experimental test in the laboratory, but evidence for the converse elementary process in which an excited atom loses its energy in a collision, partly as kinetic energy and partly as an emitted quantum, is sought for. The introduction of an atmosphere of helium or neon into a quartz tube containing fluorescing mercury vapour leads to the expected effect, namely, a spreading out from the resonance line at 2537, of two continuous bands corresponding to emission taking place during collisions between excited mercury atoms and rare gas atoms, the balance of the excitation energy equalling the difference (positive or negative) of the kinetic energy before and after collision. For argon and krypton, however, different results were obtained, indicating molecular linkage of the rare gas with the excited mercury atom. The possibility is discussed that also the "continuous" bands observed for He and Ne are in reality unresolved molecular spectra. W. S. S.

1285. Band Fluorescence of Mercury Vapour. P. Pringsheim and A. Terenin. *ZS. f. Phys.* 47. 5–6. *pp.* 330–343, 1928.

A photometrical investigation was made of the dependence of the fluorescence of mercury vapour on various conditions, the fluorescence being excited by an uncooled mercury-arc lamp or by an aluminium spark. The fluorescence brightness, for excitation with the mercury-arc lamp, is not a quadratic function of the primary intensity; it increases with increasing density of the mercury vapour, at first very rapidly and then more slowly; with small mercury vapour densities it is appreciably increased by the presence of certain gases, while with large vapour densities no such effect is observed; on the contrary, in the presence of H_2 or O_2, it is weakened. The behaviour of the emission line $\lambda 2537$ is very similar to that of the visible fluorescence. [See also Abstract 2067 (1927).] A. W.

1286. Iodine Resonance Spectra Excited by the Yellow Mercury Lines. C. N. Warfield. *Phys. Rev.* 31. *pp.* 39–51, *Jan.*, 1928.

The resonance spectra of iodine vapour in vacuum excited by the two yellow mercury lines from the Cooper-Hewitt glass lamp have been analysed. The spectra excited by the yellow line at 5771·2 Å. is found to consist of a series of doublets the main lines of which conform closely to the formula set up by Mecke from Wood's experimental data. No anti-Stokes' lines were observed to be excited by this excitation. The excitation by the yellow line at 5792·3 Å. was found to be much more complicated, consisting of three series of doublets, one of which shows two anti-Stokes' members and another shows one anti-Stokes' member. The remaining series did not show any anti-Stokes' members; however, the zero order of this series is also missing on the photographic plates. It is calculated that the molecules giving rise to the series having two, one, and no anti-Stokes' members must have vibrational energy in the unexcited state, as represented by the quantum numbers $\bar{n} \geq 2$, 1, and 1 respectively. Then, by further calculating the positions of the heads of the bands of which the excited lines are members, it is seen that there are band heads sufficiently close to these calculated values, having values of 2, 1, and 1 respectively for $\bar{n}$, but none sufficiently close having other possible values for $\bar{n}$ greater than these. AUTHOR.

1287. Hyperfine Structure and Polarisation of $1^1S_0-2^3P_1$ of Mercury in Resonance Radiation. A. Ellett and W. A. MacNair. *Phys. Rev.* 31. *pp.* 180–186, *Feb.*, 1928.

The incomplete polarisation of $\lambda 2537$ Å. of mercury in resonance radiation is due to the peculiar behaviour of the outer two hyperfine structure lines. The three remaining hyperfine structure lines behave in accordance with the predictions of the theory of the anomalous Zeeman effect for a $1^1S_0 - 2^3P_1$ line. Von Keussler's observation of complete polarisation in 7900 gauss is explained, in part at least, by the observed shift of the − 25·6 hyperfine structure line, and complete polarisation is obtained with a field of only 2000 gauss using a resonance radiation source. Authors.

1288. Fine Structure and Zeeman Effect of the Mercury Resonance Line. M. Schein. *Ann. d. Physik*, 85. 3. *pp.* 257–312, *Feb.* 4, 1928.

The resonance line was excited in one vessel by radiation from a mercury lamp and then allowed to fall upon another vessel placed between the poles of an electromagnet. The intensity at various field strengths was investigated with a photoelectric cell. Absorption measurements were also made with the secondary resonance lamp in the field and the absorption vessel outside and *vice versa*. No measurable absorption of the longitudinal Zeeman effect in a length of 4·2 mm. was found for a field of 17,000 gauss, from which it is deduced that the width of the absorption line is less than 0·076 Å. A maximum absorption coefficient was found in a layer 1·1 cm. long. F. S.

1289. Nuclear Moment and Zeeman Effect for Bismuth. E. Back and S. Goudsmit. *ZS. f. Phys.* 47. 3–4. *pp.* 174–183, 1928.

The theory of the hyperfine structure of the bismuth spectrum, as very close multiplet combinations arising from a nuclear moment [see Abstract 2901 (1927)], is found to be confirmed by the Zeeman effect of the bismuth lines in a strong field. The Zeeman effect observations enable the magnitude of the mechanical impulse moment of the nucleus to be determined. This is found equal to $4\cdot5\,\frac{h}{2\pi}$. The Zeeman effect itself constitutes the first experimental proof of the Landé theory of the fine structure in the Paschen-Back effect. W. S. S.

1290. Triatomic Hydrogen as an Emitter of the Secondary Spectrum. C. J. Brasefield. *Phys. Rev.* 31. *pp.* 52–58, *Jan.*, 1928.

It appears quite probable that some lines in the secondary spectrum of hydrogen may be emitted by an excited H_3' molecule formed by the process $H_2' + H_2 \rightarrow H_3' + H$. Thus, Richardson [see Abstract 1024 (1927)] thinks that the question of the rival claims of H_2 and H_3 to his Hα, Hβ, Hγ bands is unsettled. Allen and Sandeman [see Abstract 204 (1927)] have found a band system which they definitely ascribe to H_3. An attempt was made to verify these results by correlating the variation in the concentration of H_3^+ ions and presumably of H_3 excited molecules with the variation in intensity of the lines. The concentration of H_3^+ ions in the positive column of a glow discharge is found to decrease rapidly with pressure and becomes negligible at 0·01 mm. Reasons are given for believing that the recorded concentration of ions is even more truly representative of the conditions in a hydrogen discharge than the results given by the Lenard tubes of Smyth or of Hogness and Lunn. The relative concentration of H_3^+ has no effect on the intensity of the lines of the secondary spectrum, with the possible exception of some weak lines such as those of the Allen and Sandeman bands. Evidence is found from Lowe's curves which indicates that the Fulcher lines of Richardson's bands are emitted by the H_2 molecule. Author.

1291. Spectrum of Fluorine (FI). H. Dingle. *Roy. Soc., Proc.* 117. *pp.* 407–416, *Jan.*, 1928.

This is a continuation of previous work [see Abstract 1007 (1927)]. The spectrum has now been investigated in the region λ7600–λ8400, using neocyanine plates and a rapid glass spectrograph, the wave-lengths of 16 lines having been measured. The analysis of the spectrum previously made has been somewhat modified and extended, and an ionisation potential of 18·6 volts calculated. Relative term values of FI, based on the two metastable states of the core, have been deduced. F. S.

1292. Reversal of Helium Lines. T. Takamine and T. Suga. *Phil. Mag.* 5. *pp.* 141–149, *Jan.*, 1928.

The reversal was examined with a 33-plate echelon grating, when a long capillary tube was viewed end-on, and also when another longer and wider tube was placed between the capillary and the spectrograph. A number of tubes of special forms are described. Lines belonging to both principal and diffuse series are reversed; those belonging to the principal series, such as λ5016 ($\nu = 2S - 3P$) and λ3889 ($\nu = 2s - 3p$), which are connected with metastable states (2*s* and 2S), are distinctly absorbed in the wider tube, while those belonging to the diffuse series, such as λ6678 ($\nu = 2P - 3P$) and λ5876 ($\nu = 2p - 3d$), are reversed when the capillary alone is excited. There is a difference in clearness of reversal according to polarity on the tube. F. S.

1293. Spectra of Singly and Doubly Ionised Germanium (GeII and GeIII). R. J. Lang. *Nat. Acad. Sci., Proc.* 14. *pp.* 32–36, *Jan.*, 1928.

Measurements of the spark spectrum of germanium using a two-meter grating are reported, in the ranges 2000 Å. to 4000 Å. in air, 1250 Å. to 2400 Å. in hydrogen and 400 Å. to 4000 Å. *in vacuo.* The term schemes for the spectra GeII and GeIII are derived and discussed. W. S. S.

1294. Structure of Induction Spectra of Rare Gases. A. T. Williams. *Univ. Nac. La Plata, Estudio Ciencias, No.* 82. *pp.* 253–281, 1928.

The purpose of this paper is to establish the usefulness of excitation by the induction method to separate different orders of the spectra of any element. In the spectra of argon is established the correspondence between theoretical terms and Meissner's terms in order to the arrangement of lines in multiplets. There is also classified with Meissner's terms two new lines, 3354, $3(1S_3 - 6p_8)$ and 3355, $4(1S_3 - 6p_9)$. In the spectra of krypton there are classified 49 constant separations and two groups of lines. In the spectra of xenon the constant separations obtained are 195, and there are also several groups of lines. The validity of the method of Bloch and Déjardin [see Abstract 1471 (1924)] is considered. A. E. G.

1295. Spectra of Krypton and Xenon in the Extreme Ultra-Violet. J. H. Abbink and H. B. Dorgelo. *ZS. f. Phys.* 47. 3–4. *pp.* 221–232, 1928.

Spectra of the glow, streamer, and condensed discharge in each gas were taken in the region 1500 Å. to 500 Å. with a vacuum grating spectrograph. In addition to the resonance lines, several lines of the first spectrum of each gas were found as well as many other lines. The method used for the determination of wave-lengths is described, and tables of results are given. Ionisation potentials of 13·9 volts for Kr and 12·0 volts for Xe are calculated. F. S.

1296. Spectrum of Ionised Sodium. F. H. Newman. *Phil. Mag.* 5. *pp.* 150–159, *Jan.*, 1928.

The spectrum was produced by electrodeless discharge in a quartz tube, about 30 cm. long, and photographed with a quartz spectrograph. The measured values of wave-lengths are given in a table, together with those of other workers. A number of pairs of lines showing constant differences are given in another table. No term scheme has so far been arranged. F. S.

1297. Recombination Spectra of Atomic Ions and Electrons. F. L. Mohler. *Phys. Rev.* 31. *pp.* 187–194, *Feb.*, 1928.

Spectra were excited in a thermionic discharge tube containing a fine-wire kathode completely enclosed by a cylindrical anode. When operated with low voltage and relatively high current and vapour pressure, high ion concentration and recombination of ions and electrons were favoured. Currents from 0·05 to 0·7 ampere in cæsium vapour at pressures from 0·1 to 1 mm. gave continuous bands extending to the violet from the limit $2P_1$ of the subordinate series, from the limit of the F series and faintly beyond the P series. The intensity of these bands is rapidly increased by increasing the vapour pressure or the current. Under these conditions the higher series lines are enhanced and the F and D series relatively intense. Lines near the limit become very diffuse and the forbidden series $1S - mD$ is excited. Potassium under similar conditions shows a strong band beyond the subordinate series. Intensities of the continuous spectrum were measured throughout the visible range. The intensity reaches a maximum slightly on the red side of the limits $2P_1$ and $3D_{2,3}$ and decreases regularly and rapidly on the violet side. The two peaks are of the same magnitude with the P peak relatively greater at lower pressures. The intensity is proportional to the square of the current. The phenomena are qualitatively in accord with theory. The intensity distribution in the line spectrum indicates that there is a relatively high probability of recombination into levels of high quantum number giving radiation in the far infra-red. Recombination into the normal level is relatively improbable. AUTHOR.

1298. Measurement of the Molybdenum K-Doublet Distances by Means of the Double-X-Ray Spectrometer. B. Davis and H. Purks. *Nat. Acad. Sci., Proc.* 13. *pp.* 419–423, *June*, 1927.

It is shown that by a proper arrangement of the crystals, high resolving power can be obtained. Two split calcite crystals were mounted so that their faces formed an angle $2\theta_1$, where θ_1 is the reflecting angle. Slits were 1·5 mm. wide and 1·75 mm. high. This width of the slits permitted the reflection of a considerable range of wave-length from the first crystal at one setting. This crystal (A) acted as a collimator in that the rays of a given wave-length reflected from it were parallel to within the few seconds of arc given by the tolerance angle of the crystal (4″). The second crystal (B) acted as an analyser in that it selected from the rays reflected from A that one which made with its own face the angle θ_1. The $K\alpha$ and $K\beta$ doublets of molybdenum were investigated. For one setting of A, both Kα lines were found by rocking B and the separation was $2d\theta_1 = 292''$. The widths of the curves were about $30''$. This width was found to be independent of slit width, but not of slit height. The Kβ doublet was perfectly resolved, and the separation found was $2d\theta_1 = 40''$ ($d\lambda = 0 \cdot 00058$ Å.). [See next Abstract.] AUTHORS.

1299. Fine Structure in the K-Series of Molybdenum and the Natural Breadth of Spectral Lines. B. Davis and H. Purks. *Nat. Acad. Sci., Proc.* 14. *pp.* 172–178, *Feb.* 1928.

It has already been shown that by a proper arrangement of the crystals the resolving power of the double-X-ray spectrometer may be much increased [see preceding Abstract]. With both crystals at the first order reflection the Kβ doublet was completely resolved. It has since been found that by placing the crystals for higher order reflection, the resolving power is increased. If $d\lambda$ is the wave-length interval to be observed, $2nd\lambda = 2d \cos \theta_n d\theta_n$. The angular separation $d\theta_n$ increases with the order. In addition, the resolving power is further increased by the fact that the rocking curves become narrower at the higher order. The measurements were made at the second order on both crystals. Fine structures were observed, all on the long wave-length side of the parent line, as follows: β_1' at $0 \cdot 17$ X.U. from β_1: α_1' at $0 \cdot 085$ X.U. from α_1 and α_2' at $0 \cdot 096$ X.U. from α_2. The α_2' line was diffuse, indicating that it might be further resolved into components. Measurements attempted at the third order on α_1 gave the same $d\lambda$ as at the second order.

The rocking curves obtained from the second crystal contain (*a*) the natural width of the lines plus (*b*) the crystal imperfection, (*c*) the effect of the divergence of the beam at the surfaces of the two crystals. By placing the second crystal in a parallel position the errors due to (*b*) and (*c*) are corrected. The corrected widths seem to be less than $0 \cdot 1$ X.U. At the third order the width is still less. The results indicate that the width is less than $0 \cdot 12$ X.U. predicted by the classical theory of damping by radiation. AUTHORS.

1300. L-Series of Rhenium. H. Beuthe. *ZS. f. Phys.* 46. 11–12. *pp.* 873–877, 1928. *From the Reichsanstalt.*

Using a modified Bragg X-ray spectrograph, the L-series of rhenium (atomic number 75) has been studied, the wave-lengths being determined by comparison with standard Ni, Cu, Mo, As and Se lines. A description of the apparatus is included in the paper. W. V. M.

1301. Precision Measurements in the L-Series of the New Element 75 Rhenium. Ina Wennerlöf. *ZS. f. Phys.* 47. 5–6. *pp.* 422–425, 1928.

The three strongest lines (α_1, β_1 and β_2) in the L-series of rhenium were measured, using a preparation containing 5 % Re, 92 % Mo. The mean results are given as follows: Lα_1, $\lambda = 1429 \cdot 88$; Lβ_1, $\lambda = 1236 \cdot 04$; Lβ_2, $\lambda = 1204 \cdot 08$ X-ray units. These show satisfactory agreement with the values calculated theoretically. W. S. S.

1302. Improved Form of Gas-Type X-Ray Tube. L. F. Curtiss. *J.O.S.A. and R.S.I.* 16. *pp.* 68–70, *Jan.*, 1928.

Modifications of the Muller X-ray tube for research with soft X-radiation are described and illustrated. The present author substitutes air for water cooling and uses a compact water-jacketed antikathode so that only a single waxed joint is necessary. Pyrex glass is used for the tube body. The tube is illustrated. B. J. L.

1303. Action of the Smallest Radiation Energy on Silver Bromide. Contribution to the Question : Wave or Corpuscular Nature of Light? A. March. *ZS. f. Phys.* 46. 9–10. *pp.* 759–763, 1928.

According to Eggert and Noddack [see Abstract 2918 (1927)], by the action of X-rays on a silver bromide plate one absorbed $h\nu$ makes developable one silver bromide grain. How does silver bromide behave towards a quantity of radiation which, measured by waves per grain, does not make out one $h\nu$? Can the development of silver bromide grains be produced by a radiation in which the light consists of a wave motion energy less than $h\nu$? The inquiry gave the result that with such radiation silver bromide grains can be developed, a phenomenon which, like the photoelectric effect, can only be explained on the hypothesis of a corpuscular nature of light. J. J. S.

1304. Nature of Luminosity of Finely Divided Metals and Oxides. M. Rabinowitsch. *Kolloid Zeits.* 44. *pp.* 84–85, *Jan.*, 1928.

The paper is a criticism of the work of J. Boehm on the investigation of organic colloids by means of Röntgen rays [see Abstract 2917 (1927)]. It is mainly polemical in character, and severely criticises the conclusions deduced from the X-ray analysis of the colloids. F. J. B.

1305. Energy of X-Rays. F. Vierheller. *Univ. Nac. La Plata, Estudio Ciencias, No.* 82. *pp.* 185–196, 1928.

Discussion of the German (Behnken) and French Röntgen unit of energy of Röntgen rays. The latter presents variations. A. D.

1306. Absorption Discontinuities in the Ultra-Violet X-Ray Intermediate Region. J. Thibaud. *Comptes Rendus,* 186. *pp.* 308–309, *Jan.* 30, 1928.

In recent work [see Abstracts 2930 (1927) and 361 and 660 (1928)] the author has used a grating method and studied the K-series of light elements; but previously no continuous emission has been found. However, on using heavy targets and intense currents, this continuous radiation has now been detected. The continuous spectrum as photographed is crossed by a series of bands with sharp edges on the side of increasing frequency, the bands being due to absorption in the gases and vapours present in the tube. These are present in minute quantities and the method seems a very sensitive one. The K edges of C, N_2 and O_2 lie at 43·5, 31·1 and 23·5 Å. respectively. W. V. M.

1307. X-Ray Diffraction in Liquids : A Comparison of Certain Primary Normal Alcohols and their Isomers. G. W. Stewart and E. W. Skinner. *Phys. Rev.* 31. *pp.* 1–9, *Jan.*, 1928.

This X-ray diffraction study of certain isomers of the liquid primary *n*-alcohols confirms, in general, present conceptions concerning the alteration in shape of the chain molecule with the attachment of branches, and it emphasises the importance of the molecular space array in liquids, or the cybotactic state, and an investigation of it by X-ray diffraction. One isomer of *n*-butyl, five of *n*-amyl, one of *n*-hexyl, and two of *n*-heptyl alcohol were tested. It is found that the attachment of CH_3

as a side branch alters the "diameter" by 0·6 Å. and of OH by 0·4 Å. (Ångström units, 10^{-8} cm.). The attachment of CH_3 and of OH to the same atom in the chain increases the diameter by only 0·65 Å. The diameter is in a sense a mean value, but in the case of the di-*n*-propyl carbinol there is a better resolution, and the side attachment of OH increases the diameter in one direction by 0·45 Å. and in the other not at all. The existence is shown of associated polar groups giving two molecules in a continuous chain for each longitudinal spacing. When the OH group is not attached to the last or the next to the last atom in the chain, this association disappears and there is but one molecule for each longitudinal spacing. This is in agreement with other experiments. In the one case carefully tested, triethyl carbinol, the first, third and fifth orders of the side spacing peak are apparently present. The assumption of a molecular space array seems the only one consistent with the facts. [See also Abstract 371 (1928).] AUTHORS.

1308. X-Ray Diffraction in Liquid Normal Monobasic Fatty Acids. R. M. Morrow. *Phys. Rev.* 31. *pp.* 10–15, *Jan.*, 1928.

Eleven of the normal monobasic fatty acids in the liquid state have been investigated with MoKα radiation. The results are similar to those previously reported for the liquid primary normal alcohols by Stewart and Morrow [see Abstract 371 (1928)]. There are two spacings found by the application of Bragg's law, one of which is the lateral separation of the molecules which lie in parallel collinear chains and the other the separation of the planes passing transversely through the chains and containing the diffraction centres of the molecules. The lateral spacing is 4·55 Å. for the samples having more than five carbon atoms to the molecule. This is in agreement with the values found by Stewart and Morrow for the primary *n*-alcohols and with the work of Adam on monomolecular films. The longitudinal spacing varies linearly with the carbon content, the increase being 2·00 Å. for two molecules. In the molecular arrangement, the chains are not normal to the transverse planes and there are two molecules in series, with associated COOH groups, for each spacing. A comparison of data for the acids in the liquid and crystalline states shows that the arrangement of molecules in the cybotactic state is not that found in the crystalline state. AUTHOR.

1309. Interaction between Radiation and Electrons. A. H. Compton. *Phys. Rev.* 31. *pp.* 59–65, *Jan.*, 1928.

In the production of recoil electrons, and in the photoelectric effect for soft X-rays, experiment indicates that the whole momentum absorbed from the radiation is imparted to the electron which is ejected, indicating that the action is sensibly instantaneous compared with the natural period of the electron in the atom. The production of a recoil electron is to be regarded as an example of the action of radiation on free electrons, and conservation of momentum demands that the impulse of the recoil electron shall be nearly perpendicular to the electric vector of the incident wave. For the photoelectric effect, however, the action of radiation on a pair of positive and negative charges is concerned, and equal and opposite impulses in the direction of the electric vector may be imparted without violation of conservation of momentum. Experimentally it is found that for recoil electrons the preferred direction of motion is perpendicular to the electric vector, and for photoelectric electrons, parallel to the electric vector. A number of other similar points are discussed. W. S. S.

1310. Critical Potentials for Soft X-Ray Excitation. Ursula Andrewes, Ann C. Davies and F. Horton. *Roy. Soc., Proc.* 117. *pp.* 649–662, *Feb.* 1, 1928.

This investigation continues previous work [see Abstract 1050 (1926)], using the more convenient and more sensitive method for measuring the photoelectric current produced by the soft X-rays of observing the steady deflection of an electrometer needle instead of by timing its motion. This has the advantage of allowing a series of observations being taken more rapidly, thereby reducing chances of variations, whilst larger voltage ranges and smaller voltage intervals may be employed. Tables of data are included in the paper, giving comparisons with the results of other experimenters. H. H. Ho.

RADIOACTIVITY.

1311. Thermal Dissociation of Atomic Nuclei. S. Suzuki. *Imp. Acad. Tokyo, Proc.* 3. *pp.* 650–654, *Dec.*, 1927. *In English.*

The author has previously dealt with the thermal dissociation of the helium nucleus into protons and electrons; he now treats the problem of the dissociation of radium into radon and α-particles. This is an exothermic reaction, while that in the case of helium is endothermic. Other radioactive substances are dealt with, together with the dissociation of non-radioactive elements into others. A formula is derived for the relation between the degree of dissociation and the temperature, from which the author deduces that the amount of Ra increases with rising temperature, and that of radon diminishes, until 10^{10} degrees is reached, afterwards the Ra diminishes gradually, decomposing into radon. He and other elements of exothermic origin decompose at high temperatures without showing any such anomaly. All elements without exception must decompose into simpler ones at sufficiently high temperatures, but such temperatures are not available in the laboratory at present. H. N. A.

1312. Normal Radium Solutions. W. Bothe. *ZS. f. Phys.* 46. 11–12. *pp.* 896–898, 1928. *From the Reichsanstalt.*

In the case of the solutions investigated, without exception, the emanation output remains constant within measurement error, hence, independent in which of the vessels the solution had been stored the longest. For the oldest solution the constancy now almost reaches for seven years. A. E. G.

1313. Evolution of the Elements. B. Cabrera. *Comptes Rendus,* 186. *pp.* 228–230, *Jan.* 23, 1928.

The results of measurements by L. Meitner on the heat transformation involved in the transition $Ra \rightarrow RaC + C'$ giving 139 cal. per hour are in exact agreement with the results obtained by Aston [see Abstract 3103 (1927)] for the rate of change of the "packing fraction" with mass in this region of atomic number. W. V. M.

1314. Accurate Measurement of the Number of Ions Produced by a Single α-Particle, and Proof of the Existence of New Activities. H. Ziegert. *ZS. f. Phys.* 46. 9–10. *pp.* 668–715, 1928.

The apparatus used comprised a Hoffmann-Duant electrometer recording photographically on a revolving drum, a hollow spherical ionisation chamber contained in a copper bell jar over a massive brass plate, and an electrical arrangement by means of which the electrometer deflections due to β-rays and γ-rays could be balanced. Each α-particle produced a deflection, which appeared on the record as a sudden break in the line traced on the photographic film, the length of the line measuring the alteration in charge of the electrometer and so the number of ions produced. This length varied, since the velocities of the α-particles is different for different radioactive substances, and also because some of the α-particles hit the walls of the chamber before their energy was exhausted. The lengths of these lines were measured on a measuring machine, which is described, and were dealt with statistically in such a way that it became possible to separate the effects due to different radioactive components in a mixture. Taking Joffé's saturation theory into account, the following values were obtained for k, the number of ions produced by each α-particle in air at 0° C. and 760 mm.: UI, $1\cdot16 \times 10^5$; UII, $1\cdot29 \times 10^5$; Ra, $1\cdot36 \times 10^5$. The number of α-particles per gramme of radium per second is $Z = 3\cdot71 \times 10^{10}$. Metals for which radioactivity has not been observed were tested. No characteristic activity was found for copper or zinc, but the metals aluminium and old lead were shown to contain an amount of radium of the order of magnitude 10^{-14} gm. per gramme of metal. Residues and precipitates from solutions of zinc showed certainly the existence of new activities, the numbers of ions produced by each ray being $0\cdot42 \times 10^5$, $0\cdot69 \times 10^5$ and $1\cdot01 \times 10^5$. H. N. A.

1315. Number of α-Particles Emitted by Thorium C + C′. S. W. Watson and M. C. Henderson. *Cambridge Phil. Soc., Proc.* 24. *pp.* 133–138, *Jan.*, 1928.

With the apparatus described a fairly large total α-ray ionisation current, produced by the α-particles of both thorium C and thorium C′, was measured by a galvanometer. The curve obtained was a typical saturation curve, rising rapidly to a constant value and then rising again as ionisation by collision set in. Curves were obtained for different pressures, and the initial slope and curvature of the Bragg curve was determined. The results fit Curie and Béhounek's determination of the Bragg curve, but show a marked lack of fit with that of Henderson. The number of α-particles per second per Curie of equivalent γ-ray activity, when in equilibrium with radiothorium and when measured by the γ-rays of thorium C″ through 18 mm. of lead, was found for thorium (C + C′) to be $4\cdot26 \pm 0\cdot08 \times 10^{10}$. H. N. A.

1316. Inversion in Biotite when Acted on by α-Rays. H. Jedrzejowski. *Comptes Rendus,* 186. *pp.* 135–137, *Jan.* 16, 1928.

The α-rays from a bulb containing radon were allowed to act on a biotite plate, and the darkening produced was measured at intervals by means of a potassium photoelectric cell and a quadrant electrometer. The current of the cell drops rapidly to a minimum, and then rises slowly owing to the fact that the bright green biotite becomes rapidly coloured dark brown by the α-rays, while further action changes this colour to bright yellow and allows more light to pass. Joly has assumed the existence of an inversion of this kind to explain certain phenomena of the pleochroic haloes observed about small radioactive inclusions in certain mica crystals. H. N. A.

1317. Action of Heat on Pleochroic Haloes. J. H. J. Poole. *Phil. Mag.* 5. *pp.* 132–141, *Jan.*, 1928.

It has been known for some time that the haloes in biotite disappear if the mica is heated to a dull red. The action of heat on the reversed haloes found in Ytterby mica and other varieties has now been studied in a specially designed furnace in which the sample could be microscopically examined during heating. The temperature to produce darkening of the mica is found and also the corresponding loss in weight. The hypothesis that the haloes are produced by α-rays is then discussed. F. S.

1318. Absorption and Scattering of γ-Rays of Radium. J. A. Gray and H. M. Cave. *Roy. Soc. Canada, Trans.* 21. *Sect.* 3. *pp.* 163–171, *May,* 1927.

Using the generally assumed formulæ for the variation of σ/ρ and τ/ρ with wave-length, the authors find that the wave-length of hard γ-rays is of the order 0·018 Å. This is too large to account for the observed properties of recoil electrons. According to the distribution of scattered radiation assumed λ should be $<0{\cdot}008$ Å., or consist of a mixture of rays of wave-length 0·024 and 0·008 Å. in equal proportions. Experiments on the absorption of γ-rays indicate that there is only a small difference in wave-length between γ-rays filtered through 2 and 5 cm. of lead respectively, and hence that hard γ-rays have only a small proportion of rays of $\lambda = 0{\cdot}024$ Å. Experiments on the distribution of scattered radiation also afford no evidence of the presence in hard γ-rays of wave-lengths of the order 0·024 Å.

τ/ρ varies approximately as λ^2, and a table is given showing the variation of τ/ρ and σ/ρ with λ. A. B. W.

1319. Spectrography of γ-Rays by Means of Crystalline Diffraction. Part I. Frilley. *Comptes Rendus,* 186. *pp.* 137–139, *Jan.* 16, 1928.

Uses the revolving crystal method, the spectrograph employed being described. The crystal was of rock-salt. β-rays were deviated by an electrostatic field and absorbed. Radon was used as a source, and lines due to γ-rays from RaB and RaC lying between 35 and 284 U.X. were photographed (1 U.X. $= 10^{-11}$ cm.). The shortest wave-length measured, 35 U.X., corresponds to an energy of 353 kV, with an angle of reflection of 21·5′. The results agree well with those of corpuscular spectra up to this limit of 353 kV, except in the very complex region which includes the K lines due to fluorescence, the exact structure of which was not determined. H. N. A.

1320. Spectrography of γ-Rays by Means of Crystalline Diffraction. Part II. Frilley. *Comptes Rendus,* 186. *pp.* 425–427, *Feb.* 13, 1928.

Gives in a table the values of λ in U.X. for the different lines recorded photographically for the derivatives of radium (1 U X. $= 10^{-11}$ cm.), the corresponding energies of a quantum V in kilovolts, the intensities and the assumed origins of the γ-rays. A line due to the nucleus of RaC has $\lambda = 20{\cdot}0$, V $= 617$ kV. This is the shortest wave-length observed, and agrees with that deduced from corpuscular spectra; this is also the case for some of the nuclear lines of RaB. The highest energy previously obtained by this method in the radium family was by Rutherford and Andrade, 170 kV. This is the second order of the author's RaB line with energy 353 kV. Thibaud observed a line with 236 kV in the spectrum of mesothorium. Several K lines were observed by the author, and some remarks are made upon these. H. N. A.

HEAT.

1321. Transmission of Heat. A. Bernini. *N. Cimento*, **4.** *pp.* 404–408, *Dec.*, 1927.

The conclusions reached in a previous paper [see Abstract 131 (1928)] were criticised by P. E. Brunelli (*N. Cimento*, July, 1927]. Pending the result of further investigations in which he is engaged, the author here replies to these criticisms. E. F.

1322. Influence of the Variation of the Temperature along the Wall of Exchange on the Transmission of Heat between that Wall and a Fluid in Motion. A. Lévèque. *Comptes Rendus*, 186. *pp.* 131–133, *Jan.* 16, 1928.

It is shown that if the temperature at (X) of the surface along which a liquid at initial temperature t_1 is flowing varies with the abscissa X in such a way that the temperature difference $t_1 - t_0$ increases, then the flux of heat across the surface also increases. The increase is not only that due to the increase in the value of $t_1 - t_0$ but also to a real increase in the coefficient of convection. On the other hand, if the variation of t_0 tends to diminish the difference of temperature $t_1 - t_0$ the exchange of heat is also diminished. The formulæ obtained are also extended to a first approximation to the case of turbulent motion of a fluid in a cylindrical tube. T. B.

1323. Thermal and Electrical Conductivities of Fused Quartz as a Function of Temperature. H. E. Seemann. *Phys. Rev.* 31. pp. 119–129, *Jan.*, 1928.

The thermal conductivity as a function of the temperature has been determined for clear fused quartz by the radial flow method from 235° K. to 1225° K. The specimen was in the form of a hollow cylinder closed hemispherically at one end. Energy to maintain a steady temperature gradient was supplied by means of an electrically heated filament mounted axially inside the specimen. Thermal contact with the specimen was made with mercury inside and outside at the lower temperatures and with the tin-lead eutectic at the higher temperatures. Inside and outside temperatures were obtained with thermocouples. A guard-ring scheme was used to prevent heat loss or gain at the open end of the cylinder and correction was made for the heat flow through the hemispherical end cap. The results may be represented by the linear equation: $K = 3 \cdot 83 \times 10^{-6}T + 0 \cdot 00163$. An abrupt change in the thermal conductivity was noted in the vicinity of 1140° K. which is attributed to heat treatment, *i.e.*, annealing or partial crystallisation.

An attempt was made to measure the specific electrical resistance as a function of the temperature by the same method at the same time. The results were not conclusive because of the small amount of data taken, but there is every reason to believe that the method would be entirely successful for the determination of both quantities. The specific resistance was measured for a small piece of the original specimen. C. C. Bidwell's modification of Königsberger's formula was verified, *i.e.*, $\rho = A\epsilon(Q/RT + aT)$ $\rho = A\epsilon^{(Q/Rt+aT)}$. The results indicate the presence of both electrolytic and dielectric polarisation. Certain peculiarities in the polarisation were noted at about 1140° K. as well as a general change in the resistance-temperature curve due to heat treatment. The interpolated results are as follows:—

Temperature.....	550° K.	750° K.	950° K.	1150° K.
Specific Resistance	$4 \cdot 46 \times 10^8$	$2 \cdot 09 \times 10^7$	$1 \cdot 35 \times 10^6$	$2 \cdot 69 \times 10^5$

AUTHOR.

1324. Contribution to the Study of the Vitreous State and of the Dilatation of Glasses. M. O. Samsoen. *Ann. de Physique*, 9. *pp.* 35–127, *Jan.–Feb.*, 1928.

A phenomenon known as the "anomaly of dilatation" in glasses of various kinds has been announced in the last few years by several authors, and has been attributed by them to a transformation of the silica in the glasses. The present author has carefully measured the expansion of a great many substances and has discovered that the property in question is possessed by all substances which exist in the amorphous state. Measurements indicate that the so-called "anomaly" is really an abrupt change of the coefficient of dilatation. In the cases of glycerine and boric anhydride the change of specific heat which accompanies the transformation has also been measured. Data are given for many substances regarding the coefficient of dilatation before the transformation, the temperature of the transformation, and the coefficient of dilatation after the transformation. For example, in the case of pyrex glass, the figures are respectively: $3 \cdot 5 \times 10^{-6}$; 510° C., and 14×10^{-6}. Curves are given for several amorphous substances showing the variation of these coefficients as a function of their chemical composition. The connection of the properties examined with the processes of tempering and annealing is also discussed. T. B.

1325. True Temperature Scale of Carbon. C. H. Prescott, Jr., and W. B. Hincke. *Phys. Rev.* 31. *pp.* 130–134, *Jan.*, 1928.

The spectral emissive power of Acheson graphite for the wave-length $0 \cdot 660\,\mu$ has been determined for the temperature range from 1250° K. to 2700° K. The observations were made on a small tubular graphite resistance furnace with a hole in the wall and are best summarized by the relation: $\epsilon = 0 \cdot 984 - 5 \cdot 8 \times 10^{-5}\mathrm{T}$. Measurements of the temperature distribution along the furnace afford determinations of the ratio of resistivity to thermal conductivity at three temperatures. AUTHORS.

1326. Specific Heat of Hydrogen at High Temperatures. W. H. McCrea. *Cambridge Phil. Soc., Proc.* 24. *pp.* 80–84, *Jan.*, 1928.

The author has recalculated the specific heat of H_2 by using T. Hori's empirical values of the energy levels involved in the production of the ultra-violet bands of the H molecule [see Abstract 103 (1928)]. The calculation is similar to that employed by Kemble and van Vleck [see Abstract 292 (1924)]. The results are then compared with the values chosen by Partington and Shilling as the best representation of the observed specific heats between 273° K. and 2273° K. The agreement for the greater part of the range is good, being least accurate in the neighbourhood of 1000° K., but extremely close above 1500° K. Applying the same statistical theory, however, to gases like O_2, N_2, or CO, using the vibrational frequencies deduced from band-spectra data, it is observed that poor agreement is obtained with observed specific heats. T. B.

1327. Specific Heats of Ferromagnetic Substances. L. F. Bates. *Roy. Soc., Proc.* 117. *pp.* 680–692, *Feb.* 1, 1928.

In this paper a description is given of the thermal and magnetic behaviour of a simple ferromagnetic compound of manganese and arsenic which has a critical point at 45°. It has been found that heat is very rapidly absorbed when the substance changes from the ferromagnetic to the paramagnetic state. The thermal and magnetic phenomena are intimately connected, and the conclusion is reached that with the magnetic change there is associated a heat of transformation. It is considered that magnetic phenomena in the region of the critical point are evidence of a transformation which in this case appears to be complete at that temperature, but which, in general, may reach only a particular stage at the critical point. H. H. Ho.

1328. Classical Limit of the Space Distribution Law of a Gas in a Field of Force. N. F. Mott. *Cambridge Phil. Soc., Proc.* 24. *pp.* 76–79, *Jan.*, 1928.

The statistical mechanics developed in accordance with quantum theory deals with distribution laws over energy values only [see Fowler, Abstract 900 (1927)], and Fowler has obtained a space distribution law making use of the characteristic functions. The present author gives the analogous method of obtaining the law on the classical theory, and also shows that Fowler's formula gives the classical law for gases at ordinary temperatures and pressures. The argument is confined to the case of a perfect gas in a field of force when V is separable. T, B.

1329. Constant of Mass Action. R. D. Kleeman. *Phil. Mag.* 5. *pp.* 263–271, *Feb.*, 1928.

Molecules taking part in a gaseous reaction can be divided into two classes. One class does not dissociate while the other dissociates into molecules which do not dissociate. These are termed sepro-stable and sepro-unstable molecules. In general sepro-stable molecules obey the gas law $v = \frac{RT}{p}$, while for sepro-unstable molecules the relation $v = \frac{RT}{p} + \Sigma\frac{A_n}{p^n}$ holds, though A_n may be zero in special cases. By thermodynamic reasoning it is then shown that the constant of mass action is not necessarily independent of the volumes and masses of the constituents. A. Wh.

1330. Evaporation of Tungsten under Various Pressures of Argon. G. R. Fonda. *Phys. Rev.* 31. *pp.* 260–266, *Feb.*, 1928.

A theory of the evaporation of a heated tungsten filament immersed in an inert gas is developed in which it is assumed that the evaporating atoms diffuse through a film of stationary gas surrounding the filament. The diameter of the film is calculated from Langmuir's equation for the heat loss from a filament. The theory leads to the relation $maP \log b/a$ = constant, where m is the rate of evaporation, P is the pressure, and a and b are the diameters of the filaments and gas film respectively. By measuring the loss in weight of the filament the rate of evaporation for various gas pressures was calculated. The rates varied from 230×10^{-9} gm./cm.^{2} sec. in a vacuum to 2×10^{-9} gm./cm.^{2} sec. at a pressure of 165 cm. It is shown that when b is calculated from Langmuir's equation for heat loss the expression $maP \log b/a$ is actually constant for gas pressures in excess of 10 cm. The fact that the round filaments developed a hexagonal cross-section in accord with the normal crystalline shapes of tungsten grains is further evidence of the backward diffusion of evaporated metal with consequent condensation on the filament. AUTHOR.

1331. Highly Diluted Flames. Part I. H. Beutler and M. Polányi. *ZS. f. Phys.* 47. 5–6. *pp.* 379–406, 1928.

The reaction zone in which two gases at pressures of about 10^{-3} mm. of mercury react when flowing together into a vacuum is called a highly diluted flame. The special characteristics of such flames are found to be as follows: (1) They are cold. Heat is so quickly conducted away that the energy of reaction does not produce noticeable heating. (2) The luminosity of the flame is therefore chemiluminescence. (3) By avoidance of the extinction of excited atoms due to lack of impacts, the intensity of the luminescence rises up to several HK. The photo yield, when measured, attains 25 %. The spectral nature of the luminescence is detectable. (4) The velocity of the reaction may be calculated from the distribution of the precipitation. (5) Threefold impacts are so seldom that they may be discarded when considering the mechanism of the reaction. (6) The course of the reaction may be followed from the chemiluminescence and high photo yield. The following conclusions are drawn from the results: (1) The older assumption that free atoms react with molecules according to the scheme $A + BC = AB + C$ in the exothermic direction for each substance has been confirmed for a series of reactions between sodium and potassium with halogens and volatile halogens salts, as also with hydrogen chloride. (2) Primarily the reaction between sodium vapour and chlorine takes place as $\mathrm{Na} + \mathrm{Cl}_2 = \mathrm{NaCl} + \mathrm{Cl}$, and excites no luminosity. The light arises through the secondary reaction of the chlorine atoms with the sodium molecules, $\mathrm{Na}_2 + \mathrm{Cl} = \mathrm{NaCl} + \mathrm{Na}$, in which the NaCl which arises carries along the reaction energy in nuclear oscillations and transfers it to a free sodium atom by collision. (3) The reaction $\mathrm{Na} + \mathrm{Cl} = \mathrm{NaCl}$ takes place in the gas space at least a thousand times slower than the reaction of the chlorine atoms with the sodium molecules. [See also Abstract 1371 (1927).] H. H. Ho.

1332. Method of Measuring the Radiant Heat Emitted during Gaseous Explosions. C. H. Johnson. *Phil. Mag.* 5. *pp.* 301–322, *Feb.*, 1928.

Radiation from flames represents a considerable fraction of the total heat of combustion and lies mainly in the infra-red. A physico-chemical investigation of the radiation from a gaseous explosion necessitates careful discrimination between the emission of radiant energy from the wave front and that from the hot combustion products. To investigate this differentiation experimentally, a long narrow explosion vessel was used. The cooling of the burnt gases behind the wave thus reduced the amount of radiation from that source to a negligible minimum. A method is outlined for the calibration of a linear thermopile. The effect of water (and other catalysts) upon the emission of infra-red radiation from the wave-front in explosions of CO and oxygen was very marked. An additional 7 % of the gross heat of combustion was radiated from a dried gas mixture, in excess of that emitted in the presence of 1·9 % of water vapour. All future theories explanatory of the action of water in promoting the spread of flame through carbon monoxide-oxygen mixtures must include the consideration of this radiation factor. S. G. B.

1333. Entropy of Hydrogen Chloride. Heat Capacity from 16° K. to Boiling Point. Heat of Vaporisation. Vapour Pressures of Solid and Liquid. W. F. Giauque and R. Wiebe. *Am. Chem. Soc., J.* 50. *pp.* 101–122, *Jan.*, 1928.

The immediate purpose of the paper is given as the testing of the third law of thermodynamics, and more particularly the comparison of the entropy, as obtained from this law, with that obtained from various theories with the assistance of spectroscopic data. Hydrogen chloride was selected because of the reliability of band spectra measurements and their interpretation. Full experimental and precautionary details are given for the production of pure hydrogen chloride and a description is given of the apparatus used for the determination of vapour pressures, as also of the gold calorimetric apparatus. The heat capacity of the two solid forms and of liquid hydrogen chloride has been measured from 16° K. to its boiling point, the results being embodied in tabular form. The transition temperature is 98·36 ± 0·05° K., the melting point 158·91 ± 0·05° K., and the boiling point 188·07 ± 0·05° K. The vapour pressures of both solid and liquid, and the calorimetric determinations of the heats of transition, fusion and vaporisation have been determined, and the results are given. A form of hydrogen chloride, with a reddish-pink colour, believed to be a third crystalline form, was observed. The entropy of HCl gas was successively calculated from the calorimetric data, spectroscopic data and the Sackur equation, whilst the procedure for entropy calculation from the energy levels of a molecule as given by band spectra is discussed. The calculated and theoretical values are in good agreement. The theoretical method and the third law of thermodynamics are thus supported. The latter is also tested by means of two series of reactions and is further confirmed within the limits of error of the contributing data. S. G. B.

1334. Principle of Detailed Balancing. P. W. Bridgman. *Phys. Rev.* 31. *pp.* 101–102, *Jan.*, 1928.

The following formulation is suggested for this principle: "No system in thermal equilibrium in an environment at constant temperature spontaneously and of itself arrives in such a condition that any of the processes taking place in the system by which energy may be extracted, run in a preferred direction, without a compensating reverse process." It is shown that, granted the physical reality of the process, the principle follows from the second law of thermodynamics. AUTHOR.

SOUND.

1335. Absorption of Sound by Materials. F. R. Watson. *Univ. of Illinois Eng. Exp. Sta., Bull. No.* 172. [27 pp.], *Nov.*, 1927.

The coefficient of absorption was measured for a number of materials employable in altering the acoustic qualities of a room. The tests were made in a room with a volume of 12,180 cub. ft., and an area of material of about 72 sq. ft. was employed in each case. The main source of sound was a telephone receiver operated by current from an audible audion oscillator which gave a frequency range of 60 to 80,000 and an intensity range of about 1 : 2000. The current was amplified through a two-stage impedance-coupled amplifier, and was led through an audibility meter. The method was based on the measurement of the time of reverberation which is proportional to vol. of room × loudness ÷ absorption. The times were measured by stop-watch for the frequencies 256, 512, 1024 and 2048, (*a*) with the room bare, and (*b*) with the absorbing material placed in shallow trays on the floor. In the preliminary tests a Rayleigh disc resonator was employed to measure the sound intensities. The results are given in tables of coefficients. [See also Abstract 295 (1914).]

G. E. A.

1336. Measurement of Acoustic Impedance and Absorption Coefficient of Porous Materials. E. C. Wente and E. H. Bedell. *Bell System Techn. J.* 7. *pp.* 1–10, *Jan.*, 1928.

Various ways of determining the acoustic impedance and the absorption coefficient of porous materials from measurements on the standing waves in tubes are discussed. In all cases the material under investigation is placed at one end of the tube and the sound is introduced at the other end. Values of the coefficient of absorption of a number of commonly used damping materials as obtained by one of the methods are given. Several types of built-up structures are shown to have a greater absorption coefficient for low-frequency sound waves than is conveniently obtainable by a single layer of material. AUTHORS.

1337. Simple Method of Finding the Sound-Absorbing Power of Building Material. G. Heimburger. *Phys. Rev.* 31. *pp.* 275–282, *Feb.*, 1928.

An accurate method of comparing the absorbing powers of building materials is described. As in Taylor's method, a Rayleigh disc is used to examine the standing waves inside a tube, one end of which is closed by the test material. The main feature of the method is the comparison of the values of the maximum sound intensity in the standing waves when the end of the tube is closed first by a hard material and then by the material under test. The results are accurately reproducible. The following values of the absorption coefficient at a pitch of 295 were obtained: Commercial Celotex, 7/16 in., not perforated, 0·17; acoustical Celotex, 7/8 in., perforated side exposed, 0·34; J. M. Asbestos Akoustikos felt, ½ in. thick, one layer, 0·15; two layers, 0·43; J. M. Akoustikos felt, 1 in. thick (older type), 0·13; Akoustolith, 1 in. thick, tile, 0·15; Rumford tile, 1 in. thick, 0·22. AUTHOR.

1338. Effect of Frequency on the End Correction of Pipes. S. H. Anderson and F. C. Ostensen. *Phys. Rev.* 31. *pp.* 267–274, *Feb.*, 1928.

Using Blaikley's method, the end corrections of " closed " pipes have been determined for pipes of brass, with walls 0·12 cm. thick and the inside diameter 9·92 cm., 7·36 cm., and 4·84 cm. respectively, over a range of frequencies from 128 to 1715 vibrations per sec., and over a range of λ/D (wave-length/diameter) from 27 to 4. An electrical detector was used for determining the resonance peaks, which makes this work ten times more accurate than any formerly reported. The highest frequency used with each pipe was the limiting frequency for which resonance could be obtained, and in each case was such that λ/D = 4 approximately. The end correction was found to be dependent upon the frequency, increasing with decreasing values of λ/D to λ/D = 6 approximately, beyond which there was a decrease. The results indicate that when a pipe is used as a generator of a complex tone, (1) there is a limit to the number of partials which is determined by the value of λ/D for prime; (2) the higher proper tones will in some cases be sharp, but, generally, flat of the harmonic series, and that the corresponding partials will be of low intensity depending upon the amount of forcing required to bring them into the harmonic series. AUTHORS.

1339. Propagation Characteristics of Sound Tubes and Acoustic Filters. W. P. Mason. *Phys. Rev.* 31. *pp.* 283–295, *Feb.*, 1928.

The process of measuring the propagation characteristics of uniform sound tubes and acoustic filters is complicated by the reflections which may occur at the ends of these structures. The present paper applies some theoretical results on the effect of reflections, obtained in a previous paper [see Abstract 2579 (1927)], to the measurement of the propagation characteristics of tubes and acoustic filters. In making these measurements the device to be measured is inserted in an acoustic transmission system, and the resulting changes in the magnitude and phase of the transmitted wave are measured. The actual observations are made in electrical circuits connected with the terminals of the acoustic system by loud speakers. The impedance of the acoustic system at the point of insertion is made an acoustic resistance. For measurements on straight tubes, the acoustic resistances used are of such a value as to prevent any appreciable reflections from the ends of the tubes, and as a result the propagation characteristics of an infinite tube are obtained. The results of the measurements on straight tubes indicate that the Helmholtz-Kirchhoff law is valid, while the results of measurements on acoustic filters are in good agreement with the theoretical results obtained previously. AUTHOR.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS AND ATMOSPHERIC ELECTRICITY.

1340. Quantum Electrodynamics of Charge-Free Fields. P. Jordan and W. Pauli, Jr. *ZS. f. Phys.* 47. 3–4. *pp.* 151–173, 1928.

In this mathematical paper the Dirac theory [see Abstract 2042 (1927)], in which the electrodynamic field quantities are treated as q-numbers, is developed in the case of empty space, and commutation relations for the field quantities are laid down which are invariant to relativistic transformations. These are first applied to the amplitudes of the plane polarised waves obtained by Fourier resolutions of the field at a point, and a more general formulation is then given not requiring Fourier resolutions. A general mathematical method is given for transforming relations between q-numbers which depend continuously on the space and time coordinates, into relations between certain operators which are to be applied to generalised ψ-functions depending on the conditions throughout the field. Equations are obtained which are the analogues, for a "closed" radiation field, of the Schrödinger equation for a closed mechanical system. W. S. S.

1341. Potential Vector in a Field in Five Dimensions. J. Pacotte. *Comptes Rendus*, 186. *pp.* 362–364, *Feb.* 6, 1928.

The field equations in five dimensions, following Kaluza, implies the condition that the cylindricity of the field does not affect their form. The paper introduces an electrical potential vector of five components which enables the most general form of the field equations to be obtained. A. Wh.

1342. Observations on Atmospheric Electrical Conductivity in Connection with the Solar Eclipse of June 29, 1927. P. J. Nolan and C. O'Brolchain. *Roy. Irish Acad., Proc.* 38. 1. *pp.* 1–17, *Jan.*, 1928.

Observations were made at Llysfaen, N. Wales, on the positive and negative conductivities, potential gradient and nucleus content of the air, but the results were vitiated partly by weather conditions and partly by the presence of traffic and fires. The measurements obtained there and similar ones in county Cork are discussed with regard to the equilibrium of atmospheric ionisation. The rate of production of pairs of ions per c.c., q, is calculated from results obtained by the experimenters at various places, and an error in previous calculations of this nature is pointed out. It is found to be larger for cities than for country districts, and for the latter q increases with increasing nucleation. Possible sources of error in calculating q are examined, and while the presence of ions of intermediate sizes may increase q, the increasing contamination of the atmosphere is the more probable cause. A possible mechanism by which increasing contamination could bring about an increasing rate of production of ions in the free atmosphere is suggested. R. S. R.

1343. Cosmic Rays. R. A. Millikan and G. H. Cameron. *Nature*, 121. *pp.* 19–26, *Jan.* 7, 1928. *Supplement.*

Describes further investigations regarding the origin of the penetrating radiation [see Abstracts 1570 (1926) and 1434 (1927)]. Experiments in the Arrowhead and Gem lakes in California reveal rays so penetrating as to pass through 57 metres of water or 5 metres of lead before being completely absorbed. The new curve can be analysed for spectral distribution much more reliably than has been heretofore the case. The portion in the neighbourhood of the elevation of Arrowhead yields precisely the same coefficient as did the former curve in the same region, namely, 0·23 per metre of water, while the lowest part of the curve yields the coefficients 0·1 per metre of water, so that we have here brought to light rays nearly twice as penetrating as those heretofore found. Computed as before, the shortest wave-length is now 0·00021 Å., the equivalent generating potential of which is 59,000,000 volts, very considerably higher than the estimates made by Hoffmann. The total curve now extends from an absorption coefficient of $\mu = 0{\cdot}25$ per metre of water to $\mu = 0{\cdot}1$, or in equivalent wave-lengths computed as heretofore, 0·00053 Å. to 0·00021 Å., a range of between one and two octaves. If the computations are mady by Dirac's formula, which is probably more trustworthy than Compton's, the relative values do not change, but the absolute frequencies or energies are increased about 30 %. Special experiments are described to determine whether the position of the sun or of the Milky Way has any effect on the intensity of the rays. The results leave no possibility of assigning to the rays any other than a cosmic origin; and if the Milky Way does not differentiate itself from other parts of the sky as a source of the rays—and the experiments thus far have failed to find any such differentiation—then the rays must come, in the main, from beyond the Milky Way, *i.e.*, either from the spiral nebulæ, if these are uniformly distributed throughout the heavens, or else from the "cloud in space." The authors are now able to compute the total energy per sq. cm. per sec. that flows into the top of the earth's atmosphere in the form of the cosmic rays. It comes out at $3{\cdot}1 \times 10^{-4}$ erg cm.$^{-2}$ sec.$^{-1}$, or just one-tenth the total energy coming into the earth's atmosphere in the form of star light and heat. [See also *Phys. Rev.* 31. *pp.* 163–172, *Feb.*, 1928.] E. E. F. d'A.

1344. Measurement of Electric Fall of Potential in Air from Aircraft. A. Wigand. *Ann. d. Physik,* 85. 3. *pp.* 333–361, *Feb.* 4, 1928.

It is found that the measurement of the electric fall of potential in air from aircraft is disturbed by the electric self-charging of the motors. For that reason the charging of motors is here considered in detail. The author has previously shown in conjunction with Schlomka [see Abstract 180 (1925)] that motors on aircraft show a considerable positive self-charge. The potential fall in air is then measured, and the results obtained are recorded in detail. The space charge problem is also considered. The method of ensuring the safety of airships from effects of atmospheric electric charges is discussed. A. E. G.

DISCHARGE AND OSCILLATIONS.

1345. Sputtering of Metals by Disruptive Discharge in Magnetic Field. H. Nagaoka and T. Futagami. *Imp. Acad. Tokyo, Proc.* 30. *pp.* 643–646, *Dec.*, 1927. *In English.*

This is a continuation of previous work [see Abstract 628 (1928)]. The samples were placed in loose contact in a field of about 30 kilogauss and exploded by a heavy current. The appearance in a number of cases is discussed and illustrated. Some factors influencing the effect are also indicated. F. S.

1346. Dissipation of the Space Charge in Mercury Vapour. G. Spiwak. *ZS. f. Phys.* 46. 9–10. *pp.* 725–738, 1928.

Investigation was made of the influence of Hg vapour on the stream of electrons in a three-electrode tube. Within the pressure interval $1 \cdot 7 \times 10^{-4}$ mm. to $2 \cdot 0 \times 10^{-3}$ mm. Hg the anode current, as the emission current, if indeed the limits of tension were not exceeded, shows itself as fully stable. The J_aE_g and J_eE_g characteristic lines are rectilinear and convertible, besides the steepness of the J_aE_g characteristic line increases proportionally to the temperature, which the pressure of the mercury vapour determines. An equation is established for the connection between the strength of the emission current and the pressure of the Hg vapour on the basis of a calculation of the action of the positively-charged mercury ions on the negative space charge surrounding the glow filaments. J. J. S.

1347. Low-Pressure Electric Discharge. C. del Rosario. *Frank. Inst., J.* 205. *pp.* 103–110, *Jan.*, 1928.

A detailed account of experiments on the currents produced between a cylinder and a concentric platinum filament 5×10^{-4} cm. in diameter has recently appeared [see Abstract 1844 (1927)]. It was then found that with a field of 2×10^{6} volts per cm. at the surface of the filament, the current obtained in a vacuum of the order of 10^{-8} mm. Hg was less than $0 \cdot 5 \times 10^{-10}$ ampere. When air was admitted to a very slight extent, this current was greatly increased, and reproducible current voltage curves were obtained. The present experiments are taken to indicate that under conditions in which the vacuum is comparable with that used by former workers, and of the order of 10^{-8} mm. of Hg, the current density is not a function of the field alone for a given treatment of the wire. A. E. G.

1348. Electrodeless Ring Discharge. G. Herzberg. *ZS. f. Phys.* 46. 11–12. *pp.* 878–895, 1928.

An after-illumination which occurs in the electrodeless ring discharge in mixtures of oxygen and nitrogen is here described. With a thorough heating out of a quartz tube, the after-illumination of nitrogen, and in a certain measure also that of oxygen, can be more or less prevented; the same also applies to mixtures containing a smaller or greater quantity of other gases. The same result can also be produced, even if not so pronounced, by other previous treatment of the tube. This can be explained on the assumption that a modification of the catalytic action of the walls is necessary in order that the after illumination may occur. An extended series of experiments is described in support of this hypothesis. In addition the fluorescence and phosphorescence of glass and quartz observed with these appearances are considered. [See also Abstract 634 (1928).]
A. E. G.

1349. Electrodeless Discharges. J. S. Townsend. *Phil. Mag.* 5. *pp.* 178–191, *Jan.*, 1928.

A description is given of some of the properties of electrodeless discharges determined with tubes made up at various times to examine the spectrum of samples of gases. The tubes were of various shapes, the simplest forms being cylindrical or spherical. The electric and the electro-

magnetic forces due to current in a solenoid are discussed theoretically, and it is shown that the electric force parallel to the axis, and at a distance from it equal to the coil radius, may be relatively large. This fact is usually neglected in explanations of the currents in electrodeless tubes. Experiments with oscillatory currents of frequencies corresponding to wave-lengths between 40 and 100 m. were carried out, using open-wound solenoids surrounding spherical and cylindrical bulbs containing gas at low pressure. These experiments clearly showed the effect of the above-mentioned electric fields. Measurements were also made of the critical potentials, *i.e.*, the minimum potentials required to start and maintain discharges in various gases. The results are given in a diagram, which exhibits the variation of the critical potentials with different tube diameters and different distances apart of tinfoil electrodes wrapped round the tubes.
A. W.

1350. Impulse and Reunion in the Glow Discharge. R. Frerichs. *Ann. d. Physik*, 85. 3. *pp.* 362–380, *Feb.* 4, 1928. *From the Reichsanstalt.*

It is found that in the glow discharge in a mixture of rare gas and a small amount of metal vapour, primarily the rare gas is incited only, and secondarily it gives up the energy of its first degree of incitation so obtained, through shocks of the second kind to the admixture which by this means is incited to a certain limit. In the glow light of the hollow kathode this transfer of energy to the admixture follows for the most part direct to the ion, and nearly so to the atom. In the positive column the ion is only feebly stimulated; on the other hand, the atom is strongly incited. The present observations are in disagreement with some results obtained by Duffendack and Black on the excitation of copper spark spectra through shock of positive neon or argon ions. This difference and also one which arises in comparison with the experiments of Beutler and Josephy is briefly considered.
A. E. G.

1351. Theory of High-Frequency Currents in Gases. J. S. Townsend. *Comptes Rendus*, 186. *pp.* 55–58, *Jan.* 9, 1928.

When an oscillating field is applied by external electrodes to a long tube containing a rarefied gas, a current passes which produces, in the tube between the electrodes, a glow, uniform along the tube, but less intense near the surface than near the axis. In some experiments carried out by the author in conjunction with Donaldson and Nethercot a determination is made of the oscillating potential E, necessary to maintain a current in a tube furnished with exterior electrodes in form of a muff at distance x. If E′ and E″ are the potentials which produce the same current with distances x' and x'', it is found that $E' - E''$ is proportional to $x' - x''$. So the electric field in the uniform glow parallel to the axis is constant and equal to $(E' - E'')/(x' - x'')$. A theory to explain the results obtained is developed. The same theory takes count also of the principal properties of the current in the uniform luminous column excited in a long tube with internal electrodes when the current is maintained by a constant field.
A. E. G.

1352. Electric Discharge at High Frequency. C. and H. Gutton. *Comptes Rendus*, 186. *pp.* 303–305, *Jan.* 30, 1928.

When an alternating potential difference of very high frequency is set up between the electrodes of a tube containing rarefied gas a discharge appears which is not like that at low frequencies, and for which the law of variation of explosive potential with pressure is quite different. C. Gutton has previously shown that it is then possible to obtain illumination of the tube at very small p.d.'s. This has also been observed by Penning and by Townsend [see preceding Abstract]. The experiments here described have been undertaken to determine, for frequencies between $5 \cdot 33 \times 10^4$ and $0 \cdot 96 \times 10^8$ (wave-lengths 5620 m. and 3·2 m.), how the p.d. for which a luminous discharge is produced in hydrogen is a function of the pressure. It is also noted that with waves of more than 200 m. wave-length there is in the tubes near the electrodes a negative glow, and at the centre a positive glow of different colour, this difference is no longer visible at very high frequencies. A. E. G.

1353. Penetration of Glass in Homogeneous and Non-Homogeneous Electric Fields. Lydia Inge and A. Walther. *Arch. f. Elektrot.* 19. *pp.* 257–274, *Jan.* 25, 1928.

The influence which the fluid medium in which the substance being investigated is embedded exerts on the value of the tension required for penetration is examined. The dependence of the penetration tension on the thickness of the glass is tested in detail. The non-homogeneous electric fields in the case of glass with shock tension the penetration tension does not influence the temperature. With alternating tension its influence is also only small. In homogeneous electric fields, on the other hand, with continuous charge, even at the room-temperature, an important temperature dependence is noted. It is assumed that in non-homogeneous fields with shock tension there is a pure electric penetration, while the case for the homogeneous field can be fairly satisfactorily explained by the thermoelectric theory of Rogowski. [See also Abstracts 1492 (1927) and 165 (1928).] A. E. G.

1354. Waves Associated with Moving Electrons. J. J. Thomson. *Phil. Mag.* 5. *pp.* 191–198, *Jan.*, 1928.

The recent experiments of G. P. Thomson and Reid on the scattering of kathode rays by very thin sheets of metal or celluloid supply very direct evidence in favour of the view that a moving electron—even a uniformly moving one—is accompanied by waves whose wave-length depends on the velocity of the electron, the product of the wave-length and the velocity being constant, at any rate approximately. The existence of these waves is required by the interesting theory of wave dynamics put forward by L. de Broglie. In the present paper it is shown that the waves are also a consequence of classical dynamics if that be combined with the view that an electric charge is not to be regarded as a point without structure, but as an assemblage of lines of force starting from the charge and stretching out into space. These constitute a system of a much more detailed and elaborate character than a point charge. A. W.

1355. Experiments on the Diffraction of Kathode Rays. G. P. Thomson. *Roy. Soc., Proc.* 117. *pp.* 600–609, *Feb.* 1, 1928.

A fine pencil of kathode rays, all of approximately the same velocity, is allowed to impinge normally on a very thin film of metal or other substance, and the emergent beam received on a photographic plate, the whole course of the rays being *in vacuo*. Using films of gold, aluminium, celluloid and an unknown substance, characteristic patterns are obtained, consisting of an intense central spot due to the unscattered rays, and a number of concentric rings, some of which are not of uniform intensity. The rings are attributed to electrons scattered in accordance with the predictions of the de Broglie wave mechanics which associates with an electron a group of waves the velocity and wave-length of which are determined by the velocity and mass of the electron. The diffraction of these phase waves by the crystal lattices of the thin film should give rise to a diffraction pattern closely similar to those obtained with X-rays in the powder method. The rings observed are found to have the dimensions demanded by the de Broglie theory, to an accuracy of 5 %, and the results are to be regarded, therefore, as strong direct evidence in favour of the de Broglie conception. W. S. S.

1356. Energy Distribution among Secondary Electrons from Nickel, Aluminium and Copper. D. A. Wells. *Phil. Mag.* 5. *pp.* 367–371, *Feb.*, 1928.

Using a specially developed apparatus energy distribution curves for secondary electrons were obtained for nickel, aluminium and copper for various primary voltages. The curves for all three metals were found to be of the same general form. If the number of secondary electrons is plotted as a function of the retarding voltage, a curve is obtained which can be closely approximated by the general equation $y = ae^{bx^2}$. For nickel, with a primary voltage E of 230 volts, the equation for this curve is $I_s = 4{\cdot}3e^{-0{\cdot}000088E^2}$. [See also Abstract 592 (1924).] A. W.

1357. Absorption of Slow Electrons in Mercury Vapour. H. Beuthe. *Ann. d. Physik*, 84. 8. *pp.* 949–975, *Jan.* 13, 1928.

The method is a modification of that used by Ramsauer [see Abstract 996 (1921)]. The electronic source was a hot wire; the use of ultra-violet light presented obvious disadvantages. The electronic stream was resolved by an arrangement of slits suitably placed in a magnetic field. In this way a nearly homogeneous beam was passed through the vapour. The usual differential arrangement (depending on paths of different length) was employed. Great difficulty was experienced owing to the secondary action of the electrons on the vapour atoms; this difficulty was evaded by the use of very low pressures. The final results are shown in terms of the effective cross-section of the vapour (cm.^{2} per cm.^{3}) against the electronic voltage. There is an absorption maximum at 3 volts, and a weaker one at 4·9 volts. Their relative magnitudes are influenced by the vapour pressure. For low velocities the absorption diminishes to a very small value, mercury in this connection behaving like the rare gases. To the paper is added a short note by **F. Krüger** pointing out that the double maximum may not be a characteristic of the vapour, but may be due to a peculiarity of the electronic stream from the hot wire. A. A. D.

1358. Effective Cross-Section of Gas Molecules towards Alkali-Ions of 1–30 Volts Velocity. C. Ramsauer. *Phys. Zeits.* 28. *pp.* 858–864, *Dec.* 1, 1927. *Paper read before the Deut. Physikertag, Kissingen, Sept.*, 1927

The present investigation relates to the active cross-section of neutral gas molecules with respect to slow alkali-ions. For the production of the ions a platinum strip saturated with alkali-amalgam and caused to glow by electrical means has been employed. Full experimental details are included. The results show that the effective cross-section of argon towards alkali-ions increases on passage to smaller velocities at first slowly, but rapidly on approaching 1 volt. The paper is replete with data and illustrative curves. H. H. Ho.

1359. Recombination of Carriers in Gases. J. Schemel. *Ann. d. Physik*, 85. 2. *pp*. 137–188, *Jan*. 25, 1928.

Experiments on the recombination behaviour in gases made conducting by α-rays are carried out under three differing conditions: (*a*) during the temporary rise in the number of carriers while radiating is proceeding; (*b*) during the temporary fall in the number of carriers after a certain duration of the radiating; (*c*) during the equilibrium condition which occurs after longer radiating. The dependence of recombination on pressure between 400 and 760 mm. Hg, and also on temperature between 20° and 250° C., is investigated. The recombination does not appear to take place in a manner which might be expected from a proportionate distribution of carriers. This may take place after a long period, but with short time stronger recombination is observed. A. E. G.

1360. Temperature Dependence of the Diffusion Coefficients of Flame Gas Ions. H. Bückert. *Ann. d. Physik*, 85. 1. *pp*. 63–80, *Jan*. 18, 1928.

Previous work by Lauster [see Abstract 704 (1921)] on the temperature dependence of the mobility of flame gas ions is now continued by an investigation of the temperature dependence of their diffusion coefficients. Townsend's method of measurement was employed in which the ionised air is sucked with constant velocity through tubes of different lengths and the relative conductivities evaluated. Full experimental details are given for hydrogen, ordinary gas and carbon monoxide flames. From the magnitude of the diffusion coefficients it follows that large ionic complexes are present which possess very small velocities, but which disintegrate with rise of temperature. From an investigation on the age of the ions it was found that diffusion declined with increasing age. H. H. Ho.

1361. Refractive Index of the de Broglie Waves of the Electron. O. Klemperer. *ZS. f. Phys*. 47. 5–6. *pp*. 417–421, 1928.

The variation of the secondary emission of electrons with the angle of incidence of the primary pencil is considered from the standpoint of the de Broglie phase wave theory. It is anticipated that at a certain critical angle the associated de Broglie wave will be totally reflected. This will correspond to the electrons of the primary beam failing to penetrate into the matter and to the abrupt cut-off of secondary emission. Some previously unexplained experiments by Wehnelt and Schmidt are shown to fit in with the theory. The critical angle is related to a certain internal electrical potential of the reflecting matter, which for glass is evaluated as + 1500 volts. W. S. S.

1362. Magnetic Analysis of a Luminous Canal-Ray Beam in Hydrogen. C. J. Brasefield. *Phys. Rev*. 31. *pp*. 215–219, *Feb*., 1928.

A method is described for splitting a luminous canal ray beam in hydrogen into its four component parts, namely, the neutral, H_2^+, H^+ and H_{2-1}^+ beams, by applying a transverse magnetic field. From the variation in intensity of the H_2^+ and H_{2-1}^+ beams with pressure, the free path for dissociation into H_{2-1}^+ of a 1000-volt H_2^+ ion is found to be 0.37 cm. at a pressure of 0·01 mm., which is about one-fourth the kinetic theory value for the mean free path of a neutral hydrogen molecule. Also the ratio of the light emitted per cm. of the path by an atomic ion to that emitted by a molecular ion is found to be one-fifth. AUTHOR.

1363. Potential of Ionisation of a Molecule of Water. R. Grinfeld. *Univ. Nac. La Plata, Estudio Ciencias, No.* 82. *pp.* 283–293, 1928.

The method here adopted is that of Lenard, by collisions with electrons. A critical potential of 18·0 volts is obtained. In a discussion of the various possible cases it is found that this value should correspond with the energy necessary to detach the electron from the molecular structure. A. E. G.

1364. New Method of Measuring Excitation and Ionisation Potentials. Part I. H. Bartels. *ZS. f. Phys.* 47. 1–2. *pp.* 61–67, 1928.

The principle of a method is given for measuring excitation and ionisation potentials. It is shown to be possible to use the null-electron criterion which Hertz has introduced with his differential method for measuring excitation potentials, also for measuring ionisation potentials. A. W.

1365. New Method of Measuring Excitation and Ionisation Potentials. Part II. H. Bartels and W. Gliwitzky. *ZS. f. Phys.* 47. 1–2. *pp.* 68–71, 1928.

Measurements were made of the excitation and ionisation potentials of argon by the method previously described [see preceding Abstract]. The values found by Hertz [see Abstract 601 (1924)] for the excitation potentials of argon were 11·5, 13·0 and 13·9 volts, and the values obtained up to the present for the ionisation potential vary between 15·1 and 15·6 volts. Measurements by the new method gave the values 11·5, 12·8 and 14·0 volts for the excitation potentials, and 15·86 and 16·25 volts for the ionisation potentials. A. W.

1366. Emission of Positive Electricity from Hot Tungsten in Mullard Radio Valves. P. K. Mitra. *Phil. Mag.* 5. *pp.* 67–79, *Jan.*, 1928.

In a recent paper [see Abstract 2136 (1924)] Jenkins has shown that there is a copious emission of positive electricity from a hot tungsten wire, which forms the antikathode of a Coolidge tube, at a very high temperature, beginning from 2000° C. to 3500° C. The present investigator has worked on the same lines, but with Mullard radio valves instead of Coolidge tubes; the arrangement of apparatus, a diagram of which is given, is, however, different. An account is given of the variation of positive emission, (i) with temperature, (ii) with applied p.d., and (iii) of growth and (iv) decay of positive emission current with time under various conditions. A. E. G.

1367. Relations of Field Currents to Thermionic Currents. R. A. Millikan and C. C. Lauritsen. *Nat. Acad. Sci., Proc.* 14. *pp.* 45–49, *Jan.*, 1928.

In 1925 Millikan and Eyring [see Abstract 1437 (1926)] first developed experimentally the quantitative laws governing the extraction of electrons from metals by fields alone, *i.e.*, the laws of "field currents" as they called them. They first proved that the electrons constituting these field currents are not identical with thermions, as had heretofore been assumed. Their most significant conclusions are given as an introduction to the present paper. The facts here presented prove definitely that at high enough temperatures the fields do extract electrons which share in the energy of thermal agitation as well as those which do not. The empirical formula governing field currents (*viz.*, $i = Ce^{-b/F}$) can, therefore, be combined with the usual formula governing thermionic currents (*viz.*, $i = Ae^{-b/T}$), and so the general formula obtained for the extraction of electrons by fields or temperature—or by both—in the following form, $i = Ae^{-b/(T+cF)}$. The new results presented in this paper may be stated thus: The application of an external field is equivalent to increasing the temperature of the electrons with the metal. [See also following Abstracts.] A. E. G.

1368. Electron Theory of Metals on the Basis of the Fermi Statistics. A. Sommerfeld. *ZS. f. Phys.* 47. 1–2. *pp.* 1–32 *and pp.* 43–60, 1928.

In the first of these papers the following are the main points considered: The basis of the new statistics of Bose-Einstein and of Fermi-Dirac is developed in a simple and more extended form. The necessary mathematical expedients; the transition from the Lorentz theory of metal electrons to the Fermi statistics; conduction of heat and electricity, the Franz law; phenomena at the surface of the conductor, especially the Richardson effect. The second paper deals with the various thermoelectric, galvano-magnetic and thermomagnetic effects. Both papers are of a mathematical nature. [See also preceding and following Abstracts.] A. E. G.

1369. Electron Theory of Metals on the Basis of the Fermi Statistics—The Volta Effect. C. Eckart. *ZS. f. Phys.* 47. 1–2. *pp.* 38–42, 1928.

In this paper some of the peculiar difficulties are discussed which are met with at the surface of a metal towards a vacuum, or of one metal towards a second. The Volta effect is shown to be a physical phenomenon, without any chemical accompaniment, and is defined as the line integral of the governing fields external to the metal. [See also preceding and following Abstracts.] A. E. G.

1370. Electron Theory of Metals and Thermionic Formulæ. R. H. Fowler. *Roy. Soc., Proc.* 117. *pp.* 549–552, *Feb.* 1, 1928.

Sommerfeld recently has completely reinstated the electron theory of metallic conduction and other thermoelectric effects in good conductors by applying the Fermi-Dirac statistics to an atmosphere of free electrons in the metal of a concentration of the order of one per atom. It is the purpose of this note to call attention to an application of this theory, namely, the calculation of the density of evaporated electrons in equilibrium with the heated metal. This calculation bears on the well-known formula for thermionic emission. An argument is presented as if the observed variations in the constant A′ of the equation for the current $I = A'T^2e^{-\chi/kT}$ are to be interpreted directly as variations in the reflection coefficient of the surface. It is assumed, of course, that the current is known to be accurately of this form. The main object is to present this view and suggest that it is of some importance. Changes of A′ due to surface films

are almost invariably connected with changes in χ in a way which can be accounted for theoretically. [See also preceding and following Abstracts.]
A. E. G.

1371. Electron Emission of Cold Metals. W. V. Houston. *ZS. f. Phys.* 47. 1–2. *pp.* 33–37, 1928.

It is here shown that the Sommerfeld method of dealing with the Richardson effect of the observed electron emission from cold metals can be explained on the assumption that the external field decreases the work of setting free the electrons. [See also Abstract 1437 (1926) and preceding and following Abstracts.]
A. E. G.

1372. Extraction of Electrons from Cold Conductors in Intense Electric Fields. O. W. Richardson. *Roy. Soc., Proc.* 117. *pp.* 719–730, *Feb.* 1, 1928.

The discovery of this phenomenon seems to have evolved gradually from Earhart's experiments on very short sparks in 1901. Recently, rapid progress has been made in the investigation of this effect, especially owing to the researches of Gossling and of Millikan and Eyring [see Abstract 1437 (1926)], which have put it on a firm basis. Both Gossling and Millikan and Eyring have found that with field strengths of the order of 1 million volts per cm. electrons can be drawn out of tungsten without the co-operation of gas, that the currents vary very rapidly with the applied voltage, and under proper conditions the current is reproducible and a continuous function of the applied voltage over a wide range, and that the currents at a given voltage are independent of the temperature providing the latter is not so high as to approach the temperature at which thermionic emission becomes appreciable. These currents may attain considerable magnitude. An electron current, therefore, has to be accounted for which is independent of the temperature of the emitting substance, but which is a continuous function of the field intensity, and, indeed, to a first approximation is an exponential function of a small power of this intensity. It is suggested that none of the views of the behaviour of metallic conductors at present in circulation is capable of doing this. An hypothesis is here presented to account for these phenomena, and it is stated that if the view put forward is right the absorption spectrum of a thin metal film might be expected to have a line spectrum present in it. Experiments to test this are in progress. [See also preceding Abstracts.]
A. E. G.

1373. Refraction and Absorption of Electric Waves in Electrolytes. Part I. K. Zakrzewski. *Acad. Polonaise Sci. et Lettres, Bull.* 8*a*. *pp.* 489–503, *Oct.*, 1927.

In this paper the methods employed by the author for determining the index of absorption of aqueous electrolytes is described. In certain special cases the index of refraction has also been obtained. In the latter cases an attempt is made to verify Maxwell's equation connecting the index of refraction and the index of absorption with the electric conductivity of the electrolyte.
A. E. G.

1374. Short Undamped Electric Waves. K. Kohl. *Ann. d. Physik,* 85. 1. *pp.* 1–62, *Jan.* 18, 1928.

Following a brief outline of the various valve arrangements used by various experimenters for the generation of short continuous waves, a description is given of experiments carried out to obtain very short continuous waves. Reaction circuits of ordinary types were employed in the first experiments. By the use of specially-built valves and by making the circuit dimensions as small as possible waves of the order of 60 cm. were obtained. Still shorter waves were obtained with other arrangements in which a high positive grid potential was used. In certain valves an oscillatory circuit was sealed inside the valve. With a grid potential of the order of 600 volts it was then found possible to obtain waves of length only 30 cm. Theory is given relative to the action of the various short-wave arrangements employed. A. W.

1375. New Arrangement of Alignment for Hertzian Emissions. J. Alcardi. *Comptes Rendus*, 186. *pp.* 305–307, *Jan.* 30, 1928.

This arrangement is intended to enable navigators to follow a set course in times of fog. It consists essentially of two emitting antennæ at a slight distance apart and emitting waves of the same length, but presenting a clearly defined phase difference. When these waves are maintained and emitted with the same energy, there exists in space nodal lines along which the field, and consequently the reception, is nil. In this paper the arrangement of such a system is discussed in which one antenna emits pure waves, the other waves modulated to a musical frequency *f*. A. E. G.

1376. Rectification Efficiency of Thermionic Valves. W. E. Benham. *Phil. Mag.* 5. *pp.* 323–334, *Feb.*, 1928.

The experiments described consist of measurements on a Moullin diode-type voltmeter with a view to investigating the frequency error, the input voltage being measured by means of an electrometer of the suspended needle type. It was found that (1) for a given input voltage amplitude the rectified current is in general different at different frequencies, the frequencies used being from 4·1 to 16·8 megacycles ($\lambda 73 - \lambda 17\cdot 8$ metres); (2) the value of input voltage amplitude at which departure from square-law rectification takes place decreases as the frequency is increased. The form of the frequency variation was examined in the case where the input voltage amplitude is small enough for rectification to take place according to a square law. In this case the rectified current falls off as the frequency is increased, the rate of variation being affected by the filament temperature. With a helium-filled valve used as a triode variation of similar form and magnitude was found to occur for plate voltages below the critical potential, the variation corresponding to an increase with frequency as distinct from the decrease with a two-electrode valve. The experiments are not yet complete, and are of a preliminary nature. J. J. S.

1377. Vector Loci Method of Treating Coupled Circuits. E. Mallett. *Roy. Soc., Proc.* 117. *pp.* 331–350, *Jan.* 2, 1928.

If in the first of two coupled circuits an e.m.f. of constant amplitude and variable frequency is introduced, the currents in the primary and secondary respectively may be written $i_1 = e/Z'$ and $i_2 = e/Z''$, where Z' and Z'' are complex impedance operators. The loci of these impedances as w is varied have definite geometrical forms. Z'' is a parabola and Z' a cissoid family. The use of these loci to illustrate the well-known properties of coupled circuits is explained with examples. The effect of tight coupling leads to double hump resonance curves corresponding to the two natural frequencies possible. The current loci are the inverse of the impedance loci, and these are drawn to scale for a particular case. Many properties of coupled circuits are explained and derived from the geometry of the curves, and it is shown that with certain circuit conditions fulfilled the curves are of the same form for any type of coupling. A. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1378. Electrical Conductivity of Silicon. H. J. Seemann. *Phys. Zeits.* 28. *pp.* 765–766, *Nov.* 15, 1927, *and* 29. *pp.* 94–95, *Feb.* 1, 1928.

Although this investigation is only claimed to be of qualitative value on account of incomplete data, nevertheless the facts indicate conclusively that silicon crystals possess a positive temperature coefficient of electrical resistance. In a supplementary note the author shows that from his measurements and those of Clausing and Ryschkewitsch the elements silicon, zirconium, titanium, hafnium and thorium exhibit similar electrical behaviour to that of the metals proper, and that in consequence Koenigsberger's dissociation theory of electrical conductivity, which was based on the behaviour of semi-conductors, has lost its experimental support. H. H. Ho.

1379. Electric Resistance and its Derivative. H. Nakamoura. *Frank. Inst., J.* 203. *pp.* 783–789, *Dec.*, 1927.

Distinction is drawn between electric resistance and differential electric resistance. Thus, it is pointed out that bridge measurements with alternating current and also Mance's method measure differential resistance. Differential resistance is defined as the partial derivative of the instantaneous value of the component which is in phase with the current of the potential difference of any two points with respect to the instantaneous intensity of the current through that place. J. J. S.

1380. Resistance Change of Single Crystals of Bismuth in a Longitudinal Magnetic Field. G. W. Schneider. *Phys. Rev.* 31. *pp.* 251–259, *Feb.*, 1928.

Bismuth crystals of various orientations (angle between vertical crystallographic axis and length of specimen) show an increase in resistance in a magnetic field parallel to the specimen length. The fractional change in resistance $\Delta r/r$ is shown to be proportional to a power, slightly less than two, of the field intensity. In a maximum field of about 3500 gauss and at room-temperature the increases in resistance range from 2 to 9 %. For a constant magnetic field (3480 gauss), the change in resistance when plotted against crystal orientation, shows maxima at orientations of 63° and 80°, and minima at 0°, 73°, and 90°. This effect is substantiated by observations on specimens whose orientations have been changed by grinding or splitting, since these show the same type of variation with orientation as do the separate crystals. To determine whether the effect is due to a lack of rotational symmetry about the vertical axis some experiments are described in which the position of the vertical axis was kept fixed and the position of a minor (digonal) axis varied slightly. No observable change was found. The specific resistance, as a function of crystal orientation, obeys the Voigt-Thomson symmetry relation. Comparison with recent results by Bridgman show a considerable difference, the explanation of which has presumably been given by Bridgman. AUTHOR.

1381. Conductivities of Dilute Amalgams. A. L. Johns and E. J. Evans. *Phil. Mag.* 5. *pp.* 271–289, *Feb.*, 1928.

Dilute amalgams of germanium, gallium, copper and silver are investigated at temperatures up to 300° C. The amalgams are contained in a quartz capillary, and the vapours from boiling water, aniline, eugenol and diphenylamine are used to maintain steady temperatures, which are measured to within 1/10° C. with a platinum thermometer. A. Wh.

1382. Photoelectricity of Salts. N. Gudris and L. Kulikowa. *ZS. f. Phys.* 45. 11–12. *pp.* 801–807, 1927.

Following up the work of Koch and Vogler [see Abstract 2686 (1925)], the photo effect in a number of halides is investigated by Millikan's method of suspension between the plates of a condenser. Some of the salts are coloured by exposure to X-rays for two months. In all cases there is an increase in the wave-length of effective light with coloration, the average values being 2100 and 2200 Å. The greatest effect is observed in the case of common salt. E. E. F. d'A.

1383. General Considerations on the Photoelectric Effect. P. W. Bridgman. *Phys. Rev.* 31. *pp.* 90–100, *Jan.*, 1928.

It is shown that the equality of the stopping potentials, which is expressed in the equation $V_{AB} = (h/\epsilon)(\nu_{0B} - \nu_{0A})$, is a consequence of the principle of detailed balancing, without any assumption about the mechanism of photoelectric emission. If the relation is not satisfied, the system cannot be in equilibrium, and there must be slow transformations taking place with evolution of energy. Differentiation of the equation above gives a hold on the numerical magnitude of the temperature coefficient of the Volta difference, and also on the magnitude of the surface heat. In potassium the latter must be much larger than the ordinary Peltier heat. In a cavity in any body the equilibrium electron density is the same whether the photoelectric or the thermionic mechanisms act separately or conjointly. This gives certain connections between the photoelectric threshold frequency and thermionic emission. It is shown that the difference between the photoelectric and the thermionic work functions must be a universal constant for all metals, as must also the difference between the specific heat of the metal and a surface charge, and the difference between the entropy of the metal and a surface charge at 0° abs. Experiment makes it probable that these three universal constants are each zero. Applying this result to thermionic emission, it is probable that the abnormal emission from coated substances involves non-equilibrium conditions. Finally, it is suggested that the considerations of this paper enable another significance to be attached to the argument of Lawrence that photoelectric and thermionic emission are identical. AUTHOR.

1384. Actino-Electric Effects in Argentite. W. A. Schneider. *Phys. Rev.* 31. *pp.* 82–89, *Jan.*, 1928.

Actino-electric effects are observed in argentite, and it is shown that the seat of conversion of light into electronic energy occurs both at the contacts as well as at certain spots on the crystal. The effect is found to be absent if the crystal structure is destroyed. The actino-electric current-intensity curves show a peculiar secondary effect at certain intensities. On investigation of the actino-electric e.m.f.'s with reference to varying times of exposure and constant times of recovery it is found that an exponential relation exists between them which can be represented by $i = \mathrm{A}e^{-at}$. The *a*, however, is not a constant, but increases with time of recovery, and is the determining factor in the dark current and photoelectric hysteresis of the

crystal. It may be very intimately connected with the positive part of the primary photoelectric current as described by Gudden and Pohl.
AUTHOR.

1385. Electrodynamic Effect of the Second Order produced by Light on Metals. G. Polvani. *N. Cimento*, 4. *pp*. 399–403, *Dec.*, 1927.

When light falls on a metal the superficial electric current generated by the electric force inherent in the luminous wave is propagated under the action of the magnetic force of the wave itself, thus giving rise to a Hall effect. The electromotive force thus generated is parallel to Poynting's vector. The problem is investigated mathematically. E. F.

1386. Electromotive Force due to Friction between Various Metals. A. Lafay. *Comptes Rendus*, 186. *pp*. 133–134, *Jan*. 16, 1928.

When one metal is rubbed on another their point of contact becomes the seat of an electromotive force (e.m.f.), due partly to the contact of the two metals and partly to the rise of temperature caused by the friction. The two effects are usually in opposition, and the effect due to heat can easily be eliminated or allowed for. By giving one of the metals the form of a disc rotated at a known speed, and pressing the other metal on the rim of the disc, it is found that the e.m.f. produced is proportional to the relative speed of the two substances and is independent of the pressure which keeps them in contact. If the relative speed is V, then for speeds between 0 and 8 metres per sec. the e.m.f. of friction between silver and polished steel is 8×10^{-3} V volts, and that between copper and steel is $0 \cdot 16 \times 10^{-3}$ V volts. Also for a given value of V the e.m.f. observed is unaltered for a variation of pressure between 10 and 200 grammes per sq. mm. T. B.

1387. Contact Electricity, Thermoelectricity and Cohesion Pressure. R. v. Dallwitz-Wegner. *Z. El. Ch.* 34. *pp*. 42–49, *Jan.*, 1928.

The surfaces of solid and liquid are subject to a cohesion pressure, due to attractive forces (possibly gravitational or electric) within the molecular sphere of action which tend to draw the molecules of a body inward. The magnitude of this pressure can be deduced from some equation of state, and be expressed by the author's equation $K + P = 84 \cdot 1\gamma(1 + 1/\delta)/M$, where K is the cohesion pressure in atmospheres, P the atmospheric pressure, γ the density of the substance, δ its linear expansion coefficient. Calculations of K give very high values: for Hg at 0° (100°), 31,444 (31,200); for solids, lead 56,467 (54,000), zinc 111,000 (96,000), copper 224,000 (209,000), quartz 3,758,000 (1,965,000), diamond 12,982,000 (4,044,000). When two metals are in good contact, the pressures balance one another, and the difference in the two K, which is 113,000 for copper-zinc, is proportional to the square root of the contact electric force. In addition to diffusion of atoms there will be diffusion of free electrons. The cohesion pressure has its origin in the surface layers; it corresponds roughly to hardness. Neither the contact (Volta) effect nor the thermoelectric agree always with the calculated cohesion values, not even as to sign; but thermoelectric data are notoriously uncertain and influenced by impurities and other conditions. H. B.

1388. Electrical Properties of Ferro-Nickel-Chromium Alloys. P. Chevenard. *Comptes Rendus*, 186. *pp*. 431–433, *Feb*. 13, 1928.

The temperature of allotropic transformation and the thermal hysteresis of alloys containing 50·0 % nickel to varying percentages of chromium, 5·51 % to 15·6 %, were determined. As the percentage of chromium increased the temperature at which the allotropic change took place decreased and the thermal hysteresis increased. F. J. B.

1389. Dielectric Constants of NH_3, PH_3, AsH_3. H. E. Watson. *Roy. Soc., Proc.* 117. *pp.* 43–62, *Dec.* 1, 1927.

The measurements were made at three temperatures and three frequencies. The variations of the dielectric constant with the pressure were examined. The absolute values for NH_3 are considerably higher than those obtained by Jona [see Abstract 625 (1919)], but electric moment approximately the same. NH_3 and PH_3 approximately satisfy Debye's equation for the change in dielectric constant with temperature, with a slight deviation in the case of NH_3 at − 47° C. The electric moment for PH_3 is much smaller than for NH_3; that for AsH_3 is still smaller. A. D.

1390. Dielectric Constants of Binary Mixtures. Electric Moments of Certain Nitro Derivatives of Benzene and Toluene. J. W. Williams and C. H. Schwingel. *Am. Chem. Soc., J.* 50. *pp.* 362–368, *Feb.*, 1928.

The results are given of measurements, made by the method previously used [see Abstract 2761 (1927)], of the dielectric constants and densities of benzene solutions of nitrobenzene, *o*-, *m*- and *p*-dinitrobenzenes, *s*-trinitrobenzene, and *o*-, *m*- and *p*-nitrotoluenes at 25°. The data obtained are used for the calculation of the dielectric moments of the different solute molecules. The results of such calculations are in agreement with the physical basis furnished by various authors for the determination of the positive or negative character of the benzene substituents. T. H. P.

1391. Temperature Gradient of the Dielectric Constants of Some Gases at Various Pressures. Magdalene Forró. *ZS. f. Phys.* 47. 5–6. *pp.* 430–445, 1928.

The object of these researches, carried out with a sensitive measuring apparatus of which an illustrated description is given, was to ascertain whether in the Debye equation $\frac{\epsilon - 1T}{\epsilon + 2d} = aT + b$ the constants a and b alter or not with changing pressure. The measurements were made between room-temperature and 300° C., and the temperature gradient was observed at five or six pressures varying between vacuum and 6 atmospheres. It was found that with H_2, N_2 and air a was constant and b zero. With CO_1 b varied from zero, and the variation could be expressed equally well by a linear or a quadratic formula. With CO_2 the values obtained for b could be well represented by a quadratic formula. E. F.

1392. Piezoelectric Excitation of Longitudinal, Transverse and Torsional Vibrations in Quartz Rods. E. Giebe and A. Scheibe. *ZS. f. Phys.* 46. 9–10. *pp.* 607–652, 1928.

Describes the conditions under which the above different kinds of vibration can be produced by means of alternating electric fields applied to electrodes mounted on rods with different orientations with respect to the axis of the crystal. The distribution of the piezoelectric charges over the section and the length of the vibrating rods can be made visible and photographed by the method formerly described by the authors for longitudinally vibrating rods, using the electrical glow produced on them in a rarefied gas. Reproductions of photographs of the appearances seen in the different cases are given and explained, with the help of the mathematical theory of piezoelectricity of W. Voigt. The new modes of oscillation greatly increase the possibilities for using such rods in experiments in which piezoelectric resonators are used as standards of frequency.

H. N. A.

1393. Mechanical Oscillations of Quartz Crystals. R. Wachsmuth and H. Auer. *ZS. f. Phys.* 47. 5–6. *pp.* 323–329, 1928.

The fundamental and harmonic piezoelectric oscillations of quartz rods and slabs excited by means of an undamped oscillatory circuit were studied first by the optical method of Giebe and Scheibe [see Abstract 2593 (1925)], and then by means of polarised light and by lycopodium powder. A crystal plate of dimensions 100 × 30 × 4 mm. was employed for most of the experiments. Photographs are given showing the nodal lines exhibited by the lycopodium powder when the crystal is vibrating in one of its higher harmonics. By the measurement of the nodal distances information is obtained relative to the length of the elastic wave in the quartz, and from this the velocity of propagation can be found if the frequency is known. The propagation velocity was found for two crystal slabs to vary from about 2250 at a frequency of about 200 kilocycles to about 2700 at a frequency of about 400 kilocycles. With the crystal vibrating normal to its thickness the lycopodium powder shot up to a height of 40 to 50 cm. from the face of the crystal. A. W.

1394. Electrocapillary Microphone. M. Latour. *Comptes Rendus*, 186. *pp.* 223–224, *Jan.* 23, 1928.

A conical funnel with a capillary stem is dipped into mercury. The funnel is filled with acidulated water. Connections are made to the mercury and the electrolyte. The system acts as a microphone; a voice speaking near the arrangement is reproduced electrically in a suitably arranged reception branch of the circuit. Conversely, if an alternating e.m.f. of musical frequency is applied, then the apparatus functions as a telephone.

A. A. D.

1395. Quartz-Metal Joints and their Application to Standard Air Condensers of Low Range. D. A. Oliver. *Journ. Sci. Instruments*, 5. *pp.* 9–14, *Jan.*, 1928.

A relatively easy method of making quartz-metal joints is described. In the case of quartz rods or tubes, the ends are platinised, plated and tinned, as in Snow's glass-metal joint procedure. They are then inserted into special tinned sockets of simple form and the joint made with Wood's metal. The application of such joints to the construction of high-class air condensers of low minimum capacity is pointed out, and the design for a standard of approximately 50 micro-microfarads range is given in detail.

AUTHOR.

ALTERNATING CURRENTS AND MAGNETISM.

1396. The Current Ratio in a Non-Inductive Resistance Connected in Parallel with an Oscillatory Circuit. D. Doborzyński. *Zeits. f. Hochfrequenztechn.* 31. *pp.* 15–17, *Jan.*, 1928.

A formula is derived for the current amplitude, assuming a sinusoidal wave-form; it is shown that the condition for maximum current amplitude is also that for resonance in the oscillatory circuit. The value of the capacity to produce this is independent of the value of the shunting resistance. [See also Abstract 2615 (1927).] E. T. A. R.

1397. Magnetometer for the Measurement of the Earth's Vertical Magnetic Intensity in C.G.S. Measure. D. W. Dye. *Roy. Soc., Proc.* 117. *pp.* 434–458, *Jan.* 2, 1928.

A comprehensive description of the theory, the practical construction, use and limits of error of a new form of magnetometer for the determination of the earth's vertical magnetic intensity V, constructed at the National Physical Laboratory. The method of direct annulment of the earth's vertical field is utilised. The principle of the magnetometer involves the use of a flat vibrating coil, and is carried out as follows: The Helmholtz coil system is set up with its axis truly vertical. A small, flat, very light coil is suspended about an axis of vibration at the centre of the Helmholtz system. The plane of the coil is vertical and its axis of vibration horizontal. A relatively large alternating current is sent through the vibrating coil, at the frequency of resonant vibration, resulting in a considerable vibration from the interaction between the alternating current and the earth's vertical magnetic field. The vibration is reduced to zero, when the applied vertical field exactly annuls the earth's vertical component, and the determination of V consists of observation of the current required to give an exact condition of rest or balance on the vibrating coil. The value of this current multiplied by the known constant of the Helmholtz coil gives the value of V in C.G.S. measure corresponding to that reading. S. G. B.

1398. New Theodolite Magnetometer. R. Bock. *Zeits. Instrumentenk.* 48. *pp.* 1–14, *Jan.*, 1928.

The present instrument was designed by A. Schmidt, and is now in use in the magnetic observatory at Potsdam. In the usual type of magnetometer applied to the measurements of the earth's field, the deflecting magnet is placed in succession at two distances (30 cm. and 40 cm.) from the needle. These observations enable the effective length of the magnet to be calculated, but the method is not very accurate. In the present design the magnet is at a fixed distance from the needle, and is rotated about a vertical axis through its centre; readings are taken for a series of positions and from these observations the effective length of the magnet can be found accurately. It is to the determination of the effective length that the paper is devoted. The instrument, as regards both its construction and manipulation, is described in great detail, and a complete set of readings with their evaluation is included. The method is about seven times as accurate as that mentioned above. For a particular magnet of length 7·484 cm. the ratio of the magnetic length to the true length was found to be 0·803. A. A. D.

1399. Magnetic Properties of Single Crystals of Nickel. W. Sucksmith, H. H. Potter and L. Broadway. *Roy. Soc., Proc.* 117. *pp.* 471–485, *Jan.* 2, 1928.

The magnetic properties of single crystals of nickel are examined in the principal crystal planes. The component of magnetisation parallel to the field is measured by the induction method, whilst the component perpendicular to the field is measured by a torsion method. The reason for the use of the induction method is given, and it is shown that the existence of directional properties in the crystal invalidates the use of the torsion method for the measurement of the parallel component. The magnetisation and field coincide along the directions of the symmetry axes, the direction of easiest magnetisation being along the trigonal axis. A. E. G.

1400. Magnetic Measurements in the Lower Pyrenees, Landes and Gironde. H. Bellocq and C. Jacquet. *Comptes Rendus,* 186. *pp.* 448–450, *Feb.* 13, 1928.

Results of measurements in 1925 and 1927 of declination (D), inclination (I) and horizontal component (H) for forty-two stations are given. Compared with Moureaux's results extending from 1896 to 1922 there is for the secular variation of the elements D, I and H very good agreement for Landes and Gironde for D, I and H, and for the lower Pyrenees for D, but for H and I the agreement is not so good. R. S. R.

1401. Magnetic Measurements in North France. H. Labrouste. *Comptes Rendus,* 186. *pp.* 450–452, *Feb.* 13, 1928.

Results of measurements in 1926 and 1927 of declination (D), inclination (I) and horizontal component (H) for forty-two stations in the Nord, Pas-de-Calais and Somme are given. The mean secular variations for these magnetic elements are obtained from Moureaux's results, and they agree with the known distribution of secular variations in France. Some results from the devastated areas have been rejected. R. S. R.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

1402. An X-Ray Tube Furnishing Radiations having an Effective Wave-Length of 8 Å. A. Dauvillier. *Comptes Rendus,* 185. *pp.* 1460–1462, *Dec.* 19, 1927.

A description of an X-ray tube having a target of aluminium and a window of very thin cellophane (0·02 mm.). The minimum voltage at which an appreciable radiation is produced is 1500 volts, corresponding to the critical potential for aluminium, but the radiation is very much more intense at 3 kV. The radiation has been analysed by absorption in air and cellophane, its intensity being reduced to half-value by 1 cm. of air or 0·02 mm. of cellophane. The K-rays of aluminium (8 Å.) are practically totally absorbed by 0·1 mm. of cellophane or epidermis, and it is suggested that the new tube is a source of homogeneous and intense X-radiation having a penetration in the epidermis comparable with that of ultra-violet radiation but having a quantum three hundred times greater. W. V. M.

1403. Therapeutic Properties of X-Rays of Wave-Length 8 Å. J. Saidman. *Comptes Rendus,* 186. *pp.* 184–186, *Jan.* 16, 1928.

Describes further clinical experiments with X-rays of long wave-length [see Abstract 745 (1928)] on cases of chronic eczema, psoriasis and pruritis. Comparative results have been obtained using X-rays of wave-length 8 Å., X-rays of wave-length 1·5 to 2 Å., and ultra-violet rays. The author claims that best results are produced by the use of wave-lengths of 8 Å. The production of an erythema by the use of such rays is delayed (as in the case of ordinary X-rays), and so is unlike the more rapid produc of an erythema with ultra-violet rays. B. J. L

CHEMICAL PHYSICS AND ELECTROCHEMISTRY.

1404. Causes of the Variation in Volume accompanying the Hardening of Light Alloys of Aluminium and Copper. P. Chevenard and A. Portevin. *Comptes Rendus*, 186. *pp.* 144–146, *Jan.* 16, 1928.

Reference is made to an earlier paper [see Abstract 1155 (1923)]. It is concluded that the hypothesis that the light alloys of copper and aluminium are analogous to the martensite of steel—intermediate, that is, between the solid solution stable to heat and the aggregate stable to cold—is untenable because aluminium, unlike iron, does not exist in two allotropic forms. The anomalous reactions are put down to the presence of impurities or to the additions in the industrial alloys, such as silicon, manganese, etc., and it is in this direction that the researches are being pursued. J. K.

1405. β-Transformation in Brass and Magnetic Transformation in the Ferromagnetic Metals. C. H. Johansson. *Ann. d. Physik*, 84. 8. *pp.* 976–1008, *Jan.* 13, 1928.

The β-transformation in brass is reversible and occurs over a wide range of temperature. X-ray and microscopic examination do not reveal any molecular rearrangement associated with the change. In the present paper it is suggested: (*a*) The zinc atoms are ellipsoidal in shape, point in a definite direction in the lattice, and possess rotational thermal energy; (*b*) with rise of temperature the forces of neighbouring copper atoms weaken and the zinc atoms lose their tendency to orient themselves. The range of temperature in which the zinc atoms pass from the ellipsoidal to the spherical form is the range of the β-transformation. The temperature variation of such physical properties as electrical resistance, specific heat and thermal expansion is held to support the views advanced. Similarly, in iron, when below the Curie point, an atom is supposed to be ellipsoidal with its magnetic axis pointing along the trigonal axis. With rise of temperature the atoms swing through larger and larger angles, and finally pass into complete rotation. The views advanced are held to be supported by a consideration of certain thermomagnetic properties of iron. A. A. D.

1406. Relation between Liquidus Curves and Immiscible Liquid Ranges. C. Benedicks. *Zeits. phys. Chem.* 131. 3–4. *pp.* 285–296, *Jan.*, 1928.

In certain binary mixtures (iron-iron-sulphide, iron-copper) the liquidus curve shows a point of inflexion, and over a wide region the tangent to the curve is inclined at only a small angle to the axis of concentration. It is shown that, in such circumstances, the addition of small quantities of a third component with certain solubility properties may lead to a break in the curve. The concluding section contains some suggestions for the modification of the nomenclature as used in connection with heterogeneous equilibrium. A. A. D.

1407. Internal Pressure in Metallic Solid Solutions. R. F. Mehl. *Am. Chem. Soc.*, *J.* 50. *pp.* 73–82, *Jan.*, 1928.

Both the simple and the amplified formulæ of Richards [see Abstract 1068 (1927)] for the internal pressure can be applied for estimating the chemical affinity between metals in the state of solid solution. The author

bases his calculations of internal pressures on the thermal expansion coefficients at 35° of Johansson [see Abstract 1684 (1925)] for a series of alloys of Ag-Pd, Cu-Ni, Cu-Au, Au-Pd, Cu-Pd and Au-Ag, making use also of the scratch hardness data of Kurnakov. As palladium is added to silver the internal pressure in the solid solution increases by as much as 46 kilo-megabars for 65·7 % of Pd. This was the maximum increase found in any series. But the increase in internal pressure was always positive (when referred to the second metal in the binary alloys stated), and the increased cohesive forces account only for a very small fraction of the total hardness increase. Similar calculations are further made for Cu-Zn alloys.
H. B.

1408. Synthesis of Ammonia ; Argon as Catalyst. E. Goldstein. *ZS. f. Phys.* 47. 3–4. *pp.* 274–279, 1928.

The synthesis of ammonia takes place, not only at high temperatures and at the ordinary temperature, but also at the temperature of liquid air. When nitrogen is admitted in successive small amounts to an evacuated argon discharge tube, the nitrogen continues to combine with the aluminium kathode, the argon acting as a catalyst to the reaction.
T. H. P.

1409. Correction to "Catalytic Decomposition of Ammonia." G. M. Schwab. *Zeits. phys. Chem.* 131. *p.* 446, *Feb.*, 1928.

For original paper see Abstract 3219 (1927).

1410. Photolysis of Solutions of Hydrogen Iodide in Hexane and Water. E. Warburg and W. Rump. *ZS. f. Phys.* 47. 5–6. *pp.* 305–322, 1928.

The decomposition of hydrogen iodide in solution in water and hexane was followed by titration with $n/100$ sodium thiosulphate solution. The solutions were exposed to the action of light from spark discharge between zinc, cadmium and magnesium electrodes. It was found that hydrogen iodide in solution in hexane followed Einstein's equivalent law, but for water solutions the specific photochemical action—that is, the number of molecules of HI decomposed by each gramme calorie absorbed—departs from the equivalent law as the wave-length increased, and decreased with decreasing normality of the solution. Other water solutions behave in a similar way. It is shown that in all probability HI forms no compound with hexane, but forms a hydrate in water solution. F. J. B.

1411. Reichinstein's Displacement Principle. F. H. Constable. *Cambridge Phil. Soc., Proc.* 24. *pp.* 56–64, *Jan.*, 1928.

The maximum reaction velocity of a bimolecular reaction at a catalyst surface does not occur in general when the partial pressures of the reactants are in the ratios suggested by the chemical equation of reaction, and Reichinstein (*Die Eigenschaften des Adsorptionsvolumens*, 1916, *p.* 40) has proposed a quantitative solution of the problem on the assumption that the total number of molecules of all substances adsorbed by a given surface is constant and independent of their concentrations in the space round the surface layer. This view presents difficulties when applied to the adsorption films in the gaseous or liquid state. The molecular volumes of the several adsorbed substances may be very different, so that it is conceivable that, although the fields of force remain saturated throughout a given change in the composition of the gaseous mixture, the number of adsorbed molecules may have fallen considerably. Again, if the reacting molecules are part of a solid lattice, it is difficult to see why the total number of molecules adsorbed should be independent of the nature of the gaseous phase. In the light of present knowledge of the nature of centres of activity, an attempt is here made to deduce a new displacement principle, taking account of the lack of heterogeneity of the surface and of the Langmuir-Frenkel theory of inelastic collision of gaseous molecules with a solid surface. Various experimental results are found to be in accord with the consequences of the theory developed.

T. H. P.

1412. Combustion of Carbonic Oxide. Part I. J. P. Baxter. *Phil. Mag.* 5. *pp.* 82–96, *Jan.*, 1928.

Results are given of experiments showing the effect of water vapour in varying proportions on the explosion of mixtures of the composition $2CO_2 + O_2 + 4N_2$. As the amount of moisture is increased, the general shape of the temperature-time curve is maintained, but the time occupied in attaining the maximum temperature undergoes steady reduction. Several of the curves reveal somewhat violent temperature oscillations subsequent to the maximum temperature being reached, and these are found to be due to pressure oscillations set up inside the sphere [see Abstract 1573 (1927)]. Moreover, with increase in the time elapsing before the maximum pressure decreases, the rate of subsequent cooling tends to increase. As the water-content of the gases increases, the amount of oxides of nitrogen formed decreases very considerably, these oxides hence being produced probably as a result of the direct oxidation of carbon monoxide and not as the result of a purely thermal change. Formation of nitric oxide is favoured in a weak mixture—that is, one containing excess of oxygen. T. H. P.

1413. Studies in Homogeneous Gas Reactions. Part I. L. S. Kassel. *J. Phys. Chem.* 32. *pp.* 225–242, *Feb.*, 1928.

Various reasons are adduced in support of the definition of energy of activation, due to G. N. Lewis, as the minimum internal energy which molecules must have in order to react. The theory treated by Hinshelwood [Abstracts 2226, 2227 (1926); 823, 824, 1936, 2787 (1927)], and developed further by Rice and Ramsperger [Abstract 3008 (1927)], which is termed Theory I, and in which it is assumed that all activated molecules have the same specific reaction rate, regardless of their energy content, is in disagreement with the experimental results for the decompositions of diethyl ether, dimethyl ether, and azomethane.

On the basis of statistical mechanics an expression is deduced for the variation of the specific reaction rate of activated molecules with their energy content, and from this an equation giving the specific reaction rate for a unimolecular reaction at any pressure. This equation is in quantitative agreement with the experimental results for the decomposition of azomethane. T. H. P.

1414. Cell for the Purification of Colloids by Electrodialysis. R. Bradfield. *Indust. and Engin. Chem.* 20. *pp.* 79–80, *Jan.*, 1928.

A simple and inexpensive cell for the purification of colloids by electrodialysis is described. The cell is made out of an old rubber storage battery case. The case is cut into three sections, the cut edges are carefully trued up, so that a watertight joint can be made when the three sections are clamped together by brass clamps. The kathode is made of nickel or copper gauze, and the anode of platinum, gold, gold-plated gauze or carbon. Flowing water can be used, so that continuous electrodialysis can be carried on. The apparatus has been in use for three years and has given satisfactory results. F. J. B.

1415. Structure of the Platinicyanides : Potential of the Platino-Platinicyanide Electrode. H. Terrey. *Chem. Soc., J. pp.* 202–206, *Jan.*, 1928.

From the results of measurements of the potential of the platini-platino electrode, it is shown that part of the platinum in the so-called platinicyanides is present, not in the tervalent but in the quadrivalent state. These salts are represented more correctly by the formula $K_2Pt^{IV}(CN)_4Pt^{II}(CN)_4$ than by $KPt^{III}(CN)_4$. T. H. P.

1416. Platinum-Gold Amalgam Electrodes for Oxidation-Reduction Titration. N. H. Furman. *Am. Chem. Soc., J.* 50. *pp.* 268–273, *Feb.*, 1928.

Amalgamated gold electrodes behave like calomel electrodes in solutions containing chloride, and like mercurous sulphate electrodes in sulphate solution. Although the concentration of chloride or sulphate will vary during potentiometer titrations, the gold-amalgam electrode can be used for such titrations. A tip of gold foil or gold wire (0·33 mm. in diameter) is sealed into the end of a glass tube containing a little paraffin, and soldered to a copper wire passing up in the tube to the support of bakelite. The gold is amalgamated by momentary immersion in mercury and kept in diluted hydrochloric acid when not used. Although the mercury may itself have a reducing effect, its mass (2 mgm.) is too small to cause errors. Particulars are given of the study with these amalgam electrodes of the following reactions: bichromate-ferrous iron, permanganate-ferrous iron, vanadic acid-ferrous sulphate. The results were, for reagents of not less than 0·05 *N* so far studied, in agreement with observations made by the aid of Pt-calomel electrodes, and the gold amalgam electrode can also be used for watching the neutralisation of hydrochloric and sulphuric acid and certain precipitations. [See also Willard and Fenwick, Abstract 1694 (1923).] H. B.

1417. Use of the Platinum-Gold Electrode System. N. H. Furman. *Am. Chem. Soc., J.* 50. *pp.* 273–277, *Feb.*, 1928.

Further particulars and potential curves of the previous experiments [see preceding Abstract]. In the case of permanganate ferrous sulphate reaction the potential rises rapidly to a peak just before the end, which is followed by a very abrupt fall. In the bichromate-ferrous iron reaction in hydrochloric acid there is no pronounced peak. The acknowledged chief disadvantage of the Pt-Au system is the variable nature of the readings; the initial and maximum potentials show wide variations in magnitude, and it is difficult to judge the approach of the end-point and to predict the volt range to be expected. H. B.

1418. Continuous Reading Method of Electrometric Titration with Bimetallic Electrodes. N. H. Furman and E. B. Wilson, Jr. *Am. Chem. Soc., J.* 50. *pp.* 277–283, *Feb.*, 1928.

The electric system of the method consists of two vertical wire electrodes, one of platinum, one of tungsten, a galvanometer, a switch and a rheostat for increasing the resistance to 160,000 ohms in steps of 10,000 ohms. The end-point is the largest single permanent deflection of the galvanometer produced by a single drop of the reagent; further addition of the reagent makes little change. The reactions studied are those previously mentioned [see the two preceding Abstracts] and the iodine-thiosulphate reaction. A slight error is caused by the continuous flow of current at the expense of some reaction. Theoretical discussion is reserved. H. B.

1419. Electromotive Force of Electrolytic Thermocouples and Thermo Cells and the Entropy of Transfer and Absolute Entropy of Ions. E. D. Eastman. *Am. Chem. Soc., J.* 50. *pp.* 292–297, *Feb.*, 1928.

Equations are developed from thermodynamic considerations connecting the entropy of transfer of ions and entropy changes in single electrode reactions with the e.m.f. of certain thermoelectric cells. The equations are then applied to the calculation of the entropy of transfer for six of the common univalent kations and the chloride ion. To illustrate the possibilities of the method in the field of ionic entropies the partial molar entropy of the chloride ion was calculated. F. J. B.

1420. Potential and Activities of the Metals in Zinc Amalgam Cells. J. N. Pearce and J. F. Eversole. *J. Phys. Chem.* 32. *pp.* 209–220, *Feb.*, 1928.

Previous work on the potentials of amalgam cells showed a lack of agreement between the results obtained in different laboratories. Redetermination of the e.m.f. of amalgam cells was undertaken to endeavour to clear up the discrepancies. Mercury was carefully purified by repeated treatment with nitric acid and distillation under reduced pressure. The amalgams were made from the purest metal obtainable. The e.m.f. of zinc amalgam concentration cells were measured at 18° C., 25 C., and 25 C. The amalgam concentrations ranged from N = 0·0003024 up to saturation. The change in free energy, heat content and entropy accompanying dilution have been computed, and the activities of zinc and mercury in the various amalgams were calculated. Deviations were observed between the ideal and the measured potentials, which increase as the concentration of the zinc increased. The deviation was approximately zero at infinite dilution. The general results are in agreement with those of Richards and Forbes. F. J. B.

1421. Dispersion of Metals in Solid Salts under the Action of an Electric Current. T. Peczalski. *Comptes Rendus,* 185. *pp.* 1588–1591, *Dec.* 27, 1927.

An iron tube filled with a salt has a rod of the metal along its axis. The tube was placed in an electric furnace whose temperature was maintained below the melting point of the salt. When the desired temperature is reached the tube and the rod are joined to the poles of an electric generator at 220 volts. In the circuit a lamp having a resistance of about 500 ohms is placed. The current through the salt is measured and the p.d. between the iron tube and the metallic rod. The results of an experiment on KCl are given. The conductivity of the salt, at first very small, rises 1000 times after an hour of the passage of the current. This rise is more rapid when the rod of copper is joined to the positive pole. When the tubes are cut perpendicularly to the axis it is noticed that (1) the positive pole being joined to the copper rod, the latter dissolves in the salt, producing blackening of the salt round the rod; (2) the positive pole being joined to the iron tube, the current carries the iron into the salt, which becomes brown round the tube. Rings coloured red were observed in the parts of the tube where the temperature was lower than in the middle. These rings contained very small quantities of copper shown by microscopic analysis made with hematoxylin. Similar experiments were made with other salts. The facts may be explained by the emission of ions from the metal. The ions penetrate into the salt and form there a layer of metal which in its turn emits ions until metallic contact between the kathode and the anode is set up. It is possible also that electrolysis of the vapours of the salts takes place. J. J. S.

1422. Catalytic Phenomena in the Solution of Aluminium. M. Centnerszwer. *Zeits. phys. Chem.* 131. 3–4. *pp.* 214–225, *Jan.*, 1928.

Following the investigation of the effect of different metals on the rate of solution of zinc, the work was extended to aluminium. Aluminium, like zinc, is passive in acid solutions, and the presence of other metals in contact with the aluminium increases the rate of solution. The rate of decrease of current in a Al-Pt cell in $\frac{1}{2}$N . HCl, and the overvoltage of an Al electrode in combination with electrodes of other metals were observed. It was found that metals which lower the overvoltage accelerate the rate of solution of Al in HCl, when in contact with the aluminium. Aluminium is so strongly " passive " in sulphuric acid that it is not activated by platinum. If HCl is added, even in small amounts, the metal is activated. The action of mercury is fundamentally different from other metals. F. J. B.

1423. Free Space Charges in Electrolytes. A. Coehn and R. Schnurmann. *ZS. f. Phys.* 46. 5–6. *pp.* 354–373, 1928.

The question whether free space charges can be observed in electrolytes as in gases is solved by the investigation of a newly discovered phenomenon in the electrolytic development of gases from very weak electrolyte solutions. The conditions for the appearance of the back radiation of gas were examined, and it was found that this, which consists in an outgoing liquid and gas motion directed from the electrodes, comes into action at so much the smaller electrode potential the fewer the ions the electrolyte contains, and the greater the difference of the mobility of the kation and anion. It is concluded that in an electrolyte very poor in ions with great fall of potential at the electrode, Hittorff's scheme for the wandering of the ions no longer holds, so far it merely permits changes of concentration of the neutral electrolyte at the electrodes, that much more here a surplus of one kind of ion, *i.e.*, a free space charge is noticeable. The great velocity which the ions attain in direct proximity to a point electrode, and by which they pass through liquid and gas, may occur not only on account of the back radiation, but also through the hydrostatic pressure, the absorbent action, which the liquid exerts in direct proximity to the electrodes. J. J. S.

1424. Calculation of the Equivalent Conductivities of Strong Electrolytes at Infinite Dilution. Part II. (1) Methyl Alcohol Solutions; (2) Effect of Temperature on the Constants of the Equation $\Lambda_0 = \Lambda + BC^n$. I. Vogel. *Phil. Mag.* 5. *pp.* 199–204, *Jan.*, 1928.

Continuing work which has been published [see Abstracts 3232 and

3237 (1927)], the present paper deals with the effect of temperature on the equivalent conductivity of strong electrolytes in methyl alcohol solution. The effect of temperature on the constants of the equation $\Lambda_0 = \Lambda + BC^n$ was calculated from measurements of the conductivity of potassium iodide in nitromethane, measured at 0°, 25°, 40°, 55° and 70°. Both the constants were found to increase steadily with the temperature up to 55°, and then pass through a maximum between this temperature and 70°.

F. J. B.

1425. Refractometric Information on the Condition of Strong Electrolytes in Concentrated Solutions. K. Fajans, H. Kohner and W. Geffcken. *Z. El. Chem.* 34. *pp.* 1–10, *Jan.*, 1928. *Paper read before the Deut. Bunsen Gesell., May*, 1927.

Refractometric measurements of solutions of strong electrolytes were found to yield data on the dissociation and association of the ions in the solutions. The paper summarises and discusses earlier work in this field, and shows that the results are in agreement with the theory of solutions obtained from other data. F. J. B.

1426. Electronic Theory of Valency. Part VI. The Molecular Structure of Strong and Weak Electrolytes. (*b*) **Reversible Ionisation. T. M. Lowry.** *Faraday Soc., Trans.* 24. *pp.* 1–10; *Disc.*, 25–32, *Jan.*, 1928.

The cases of electrolytes in which the ionisation is reversible instead of complete is reviewed. Although in most electrolytes ionisation is complete, even in the solid state, there are many compounds in which the ionisation is incomplete and reversible. Compounds of this type, in which neutralisation is not prevented by the laws of valency, behave as "weak electrolytes" unless the bond between the radicals is too weak to hinder the ionisation of the molecule. Weak electrolytes of this class are found amongst acids and bases, pseudo-electrolytes, coordinated salts, and a few simple metallic salts, such as mercuric chloride, where covalent molecules can be formed from the ions. F. J. B.

1427. Effect of Temperature on Diffusion Potentials. E. B. R. Prideaux. *Faraday Soc., Trans.* 24. *pp.* 11–14, *Jan.*, 1928.

The variation of the relationships between diffusion and membrane potentials with temperature for the alkali metal salts and some alkali salts of organic acids. The variations found did not exceed the error of experiment, and this constancy renders it possible to carry out the measurements of diffusion potentials without a thermostat. The results lead to the conclusion that the diffusion potentials between different concentrations of the same strong electrolytes have, as a class, very low temperature coefficients. F. J. B.

1428. Ionisation of Polyhydrion Acids. C. Morton. *Faraday Soc., Trans.* 24. *pp.* 14–25; *Disc.*, 25–32, *Jan.*, 1928.

A series of potentiometric titrations of organic acids was made, and from these results data regarding the dissociation constants for the acids were obtained. The results showed that the methods employed by Enklaar and by Auerbach and Smolczyk in computing the dissociation constants for tribasic acids is based on false assumptions. The acetate buffer mixtures of Walpole, and the phthalate-NaOH, and the phosphate-

NaOH mixtures of Clark and Lubs, may be formulated in terms of the Debye-Hückel theory of inter-ionic forces. The value $k_a = 1\cdot77 \times 10^{-5}$ is found to satisfy the neutralisation curve of acetic acid. The dissociation constants of tricarballyllic acid, camphronic, and citric acids have been determined. The results are in general agreement with the known effects of substitution on the strength of acids. The new apparatus for potentiometric titration, and a new method of differential titration, are described.

F. J. B.

1429. Electrocapillary Properties of Mercury. G. Colange. *Comptes Rendus*, **186.** *pp.* 74–75, *Jan.* 9, 1928.

Deals with the case where the mercury is in contact with air. High potentials are required, and the diameter of the tube should be over 0·1 mm. The mercury in the tube is connected to one pole of an electrostatic machine, and it is found that the mercury sinks in the tube if it is connected to the + pole, and rises if it is connected to the − pole. This is not due to electrification of the glass, but to an increase in the capillary constant when the Hg is given a negative charge, and a decrease with a positive charge. There is a maximum value of the capillary constant for a negative potential of from 15,000 to 20,000 volts; a higher negative voltage diminishes the constant. H. N. A.

1430. Kathodic Overvoltage. E. Liebreich and W. Wiederholt. *Z. El. Chem.* 34. *pp.* 28–41, *Jan.*, 1928.

The current-potential curves were determined for copper, silver, gold, platinum, palladium, carbon and graphite, in 0·02 *N* sulphuric acid, and hydrochloric acid, and in 0·02 *N* sodium hydrate solutions. All the metals showed a period of kathodic activation shortly before the evolution of hydrogen gas commenced. This was not shown by carbon, and only in a slight measure by graphite. The observations lead to the conclusion that the connection between kathodic activation and the kathodic overvoltage consists in the formation of hydrates or basic salts during the activation period, which form a thin layer, and delay the evolution of hydrogen mechanically, or require reduction before the gas evolution can commence. The overvoltage is a consequence of the formation of this surface layer. The activation is caused by occlusion or adsorption of the first hydrogen ions discharged, and a combination of the metal with the hydroxyl ions which exist in the immediate vicinity of the kathode. The protective layer is not formed on carbon, and any activation must be ascribed to the formation of hydrocarbons, the occlusion of these gases and of hydrogen by the electrode. The kathodic overvoltage is intimately connected with the tendency of the metal to form a more or less impermeable surface layer, and hence the question is of importance in cases of corrosion. F. J. B.

1431. Activity Coefficients of Small Ions. H. Müller. *Phys. Zeits.* 29. *pp.* 78–82, *Feb.* 1, 1928.

The activity coefficients are derived from considerations given in a previous paper [Abstract 2644 (1927)]. The mathematical theory is discussed, and the conclusions of several other workers in this field are criticised. The paper does not lend itself to abstracting. F. J. B.